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NASA TM X- 73957-3

(NASA-TM-X-73957-3) LaRC DESIGN ANALYSIS  
REPORT FOR NATIONAL TRANSONIC FACILITY FOR  
304 STAINLESS STEEL TUNNEL SHELL. VOLUME  
3S: FINITE ELEMENT ANALYSIS OF PLENUM  
REGION INCLUDING SIDE ACCESS REINFORCEMENT, G3/39

Unclas  
07179

## A circular stamp with a black border. Inside the circle, the text "OCT 1976" is at the top, "RECEIVED" is in the middle, and "NASA STI FACILITY" and "INPUT BRANCH" are at the bottom. The stamp is slightly tilted.

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7. Author(s) J. W. Ramsey, Jr., J. T. Taylor, J. F. Wilson, C. E. Gray, Jr., A. D. Leatherman, J. R. Rooker, and J. W. Allred				8. Performing Organization Report No.	
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15. Supplementary Notes Formal Documentation of Design Analyses to Obtain Code Approval of Fabricated National Transonic Facility					
16. Abstract This report contains the results of extensive computer (finite element, finite difference and numerical integration), thermal, fatigue, and special analyses of critical portions of a large pressurized, cryogenic wind tunnel (National Transonic Facility). The computer models, loading and boundary conditions are described. Graphic capability was used to display model geometry, section properties, and stress results. A stress criteria is presented for evaluation of the results of the analyses. Thermal analyses were performed for major critical and typical areas. Fatigue analyses of the entire tunnel circuit is presented.  The major computer codes utilized are: SPAR - developed by Engineering Information Systems, Inc. under NASA Contracts NAS8-30536 and NAS1-13977; SALORS - developed by Langley Research Center and described in NASA TN D-7179; and SRA - developed by Structures Research Associates under NASA Contract NAS1-10091; "A General Transient Heat-Transfer Computer Program for Thermally Thick Walls" developed by Langley Research Center and described in NASA TM X-2058.					
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NATIONAL TRANSONIC FACILITY

TUNNEL SHELL

NASA - LARC

FINITE ELEMENT ANALYSIS

OF

PLENUM REGION

INCLUDING

SIDE ACCESS REINFORCEMENT,

SIDE ACCESS DOOR

AND

ANGLE OF ATTACK PENETRATION

304 STAINLESS STEEL

SEPTEMBER 1976

VOLUME 3S



LaRC CALCULATIONS  
FOR THE  
NATIONAL TRANSONIC FACILITY  
TUNNEL SHELL

DATE: SEPTEMBER, 1976

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This report is one volume of a Design Analysis Report prepared by LaRC on portions of the pressure shell for the National Transonic Facility. This report is to be used in conjunction with reports prepared under NASA Contract NAS1-13535(c) by the Ralph M. Parsons Company (Job Number 5409-3 dated September 1976) and Fluidyne Engineering Corporation (Job Number 1060 dated September 1976). The volumes prepared by LaRC are listed below:

1. Finite Difference Analysis of Cone/Cylinder Junction (304 S.S.) Vol. 1, NASA TM X-73957-1.
2. Finite Element Analysis of Corners #3 and #4 (304 S.S.), Vol. 2S, NASA TM X-73957-2.
3. Finite Element Analysis of Plenum Region Including Side Access Reinforcement, Side Access Door and Angle of Attack Penetration (304 S.S.), Vol. 3S, NASA TM X73957-3.
4. Thermal Analysis (304 S.S.) Vol. 4S, NASA TM X73957-4.
5. Finite Element and Numerical Integration Analyses of the Bulkhead Region (304 S.S.), Vol. 5S, NASA TM X73957-5.
6. Fatigue Analysis (304 S.S.), Vol. 6S, NASA TM X73957-6.
7. Special Studies (304 S.S.), Vol. 7S, NASA TM X73957-7.

NTF DESIGN CRITERIA  
FOR 304 STAINLESS STEEL

GENERAL

THE DESIGN OF THE PRESSURE SHELL REFLECTED IN THIS REPORT SATISFIES THE DESIGN REQUIREMENTS OF THE ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII, DIVISION 1. SINCE DIVISION 1 DOES NOT CONTAIN RULES TO COVER ALL DETAILS OF DESIGN, ADDITIONAL ANALYSES WERE PERFORMED IN AREAS HAVING COMPLEX CONFIGURATIONS SUCH AS THE CONE CYLINDER JUNCTIONS, THE GATE VALVE BULKHEADS, THE BULKHEAD-SHELL ATTACHMENTS, THE PLENUM ACCESS DOORS AND REINFORCEMENT AREAS, THE ELLIPTICAL CORNER SECTIONS, AND THE FIXED REGION (RING S8) OF THE TUNNEL. THE DIVISION 1 DESIGN CALCULATIONS, THE ADDITIONAL ANALYSES AND THE CRITERIA FOR EVALUATION OF THE RESULTS OF THE ADDITIONAL ANALYSES TO ENSURE COMPLIANCE WITH THE INTENT OF DIVISION 1 REQUIREMENTS ARE CONTAINED IN THE TEXT OF THIS REPORT. THE DESIGN ANALYSES AND ASSOCIATED CRITERIA CONSIDERED BOTH THE OPERATING AND HYDROSTATIC TEST CONDITIONS.

IN CONJUNCTION WITH THE DESIGN, A DETAILED FATIGUE ANALYSIS OF THE PRESSURE SHELL WAS ALSO PERFORMED UTILIZING THE METHODS OF THE ASME CODE, SECTION VIII, DIVISION 2.

MATERIAL

THE PRESSURE SHELL MATERIAL SHALL BE ASME, SA-240, GRADE 304 FOR PLATE AND SA-182, GRADE F304 FOR FORGINGS. THE MATERIAL PROPERTIES AT TEMPERATURES EQUAL TO OR BELOW 150°F ARE AS FOLLOWS:

(A) PLATE

YIELD = 30.0 KSI  
ULTIMATE = 75.0 KSI

(B) WELDS (AUTOMATIC, SEMIAUTOMATIC, OR "STICK")

YIELD = 30.0 KSI  
ULTIMATE = 75.0 KSI

OPERATING, DESIGN AND TEST CONDITIONS

THE OPERATING, DESIGN AND TEST CONDITIONS FOR THE TUNNEL PRESSURE SHELL AND ASSOCIATED SYSTEMS AND ELEMENTS ARE SUMMARIZED BELOW:

1. OPERATING MEDIUM

ANY MIXTURE OF AIR AND NITROGEN

2. DESIGN TEMPERATURE RANGE

MINUS 320 DEGREES FAHRENHEIT TO PLUS 150 DEGREES FAHRENHEIT, EXCEPT IN THE REGION OF THE PLENUM BULKHEADS AND GATE VALVES INSIDE A 23-FOOT, 4-INCH DIAMETER, FOR WHICH THE TEMPERATURE RANGE IS MINUS 320 DEGREES FAHRENHEIT TO PLUS 200 DEGREES FAHRENHEIT.

3. PRESSURE RANGE

TUNNEL CONFIGURATION	OPERATING PRESSURE RANGE, PSIA	DESIGN PRESSURES PSID
A. CONDITION I - PLENUM ISOLATION GATES OPEN AND TUNNEL OPERATING:		
TUNNEL CIRCUIT EXCEPT PLENUM	8.3 to 130	A. 8 EXTERNAL B. 119 INTERNAL
PLENUM (PLENUM PRESS- URE IS LIMITED TO .4 TO 1 TIMES THE REMAINDER OF THE TUNNEL CIRCUIT	3.3 to 130	A. 15 EXTERNAL B. 119 INTERNAL
BULKHEAD		56 (EXTERNAL TO PLENUM)
B. CONDITION II - PLENUM ISOLATION GATES OPEN AND TUNNEL SHUTDOWN:		
ENTIRE TUNNEL CIRCUIT	8.3 to 130	A. 8 EXTERNAL B. 119 INTERNAL
BULKHEAD		0
C. CONDITION III - PLENUM ISOLATION GATES AND ACCESS DOORS CLOSED:		
TUNNEL CIRCUIT EXCEPT PLENUM	8.3 to 130	A. 8 EXTERNAL B. 119 INTERNAL

PLENUM (PLFNUM OPER-  
ATING PRESSURE CAN  
EXCEED THE PRESSURE  
IN THE REMAINDER OF  
THE TUNNEL CIRCUIT BY  
24 PSI, BUT DOES NOT  
EXCEED THE 130 PSIA  
MAXIMUM OPERATING  
PRESSURE)

0 to 130

- A. 15 EXTERNAL
- B. 119 INTERNAL

BULKHEAD

- A. 25 (INTERNAL TO  
PLENUM)
- B. 119 (EXTERNAL TO  
PLENUM) FOR MINUS  
320 DEGREES  
FAHRENHEIT TO  
PLUS 150 DEGREES  
FAHRENHEIT

- \*C. 115.7 (EXTERNAL TO  
PLENUM) FOR PLUS  
151 DEGREES  
FAHRENHEIT TO PLUS  
200 DEGREES  
FAHRENHEIT

\*OPERATING PROCEDURES LIMIT PRESSURES TO THAT SHOWN.

D. CONDITION IV - PLENUM  
ISOLATION GATES CLOSED  
AND ACCESS DOORS OPEN:

TUNNEL CIRCUIT EXCEPT  
PLENUM

8.3 to 130

- A. 8 EXTERNAL
- B. 119 INTERNAL

PLENUM

14.7

0

BULKHEAD

- A. 119 (EXTERNAL TO  
PLENUM) FOR MINUS  
320 DEGREES FAHRENHEIT  
TO PLUS 150 DEGREES  
FAHRENHEIT
- \*B. 115.7 (EXTERNAL TO  
PLENUM) FOR PLUS 151  
DEGREES FAHRENHEIT TO PLUS  
200 DEGREES FAHRENHEIT

\*OPERATING PROCEDURES LIMIT PRESSURES TO THAT SHOWN.

#### 4. HYDROSTATIC TEST DESIGN CONDITIONS

THE PRESSURE SHELL WAS DESIGNED FOR HYDROSTATIC TEST IN ACCORDANCE WITH THE REQUIREMENTS OF THE ASME CODE, SECTION VIII, DIVISION 1. THE TEST PRESSURES SHALL BE AS FOLLOWS. PRESSURE SHELL TEMPERATURE SHALL BE EQUAL TO OR BELOW 100°F DURING HYDROSTATIC TESTS.

CONDITION (1) - MAXIMUM INTERNAL PRESSURE CONDITION FOR THE ENTIRE TUNNEL CIRCUIT

$$\begin{aligned} PH_1 &= 1.5 (119) \left( \frac{18.7}{18.2} \right) + \text{HYDROSTATIC HEAD} \\ &= 183.4 \text{ PSI} + \text{HYDROSTATIC HEAD} \end{aligned}$$

CONDITION (2) - MAXIMUM DIFFERENTIAL PRESSURE CONDITION ACROSS THE PLENUM BULKHEADS

$$\begin{aligned} PH_2 &= 1.5 \left( \frac{18.7}{18.2} \right) (119) + \text{HYDROSTATIC HEAD} \\ &= 183.4 + \text{HYDROSTATIC HEAD} \end{aligned}$$

$$\begin{aligned} PH_2^* &= 1.5 (115.7) \left( \frac{18.7}{17.7} \right) + \text{HYDROSTATIC HEAD} \\ &= 183.4 + \text{HYDROSTATIC HEAD} \end{aligned}$$

\*TUNNEL OPERATION LIMITATIONS PRECLUDE PRESSURE DIFFERENTIALS ACROSS BULKHEADS IN EXCESS OF 115.7 PSI FOR BULKHEAD AND GATE TEMPERATURES IN EXCESS OF 150°F.

CONDITION (3) - MAXIMUM REVERSE DIFFERENTIAL PRESSURE CONDITION ACROSS THE PLENUM BULKHEADS

$$PH_3 = 1.5 \left( \frac{18.7}{18.2} \right) (25) = 38.5 \text{ PSI}$$

THE PRESSURE SHELL EXCEPT FOR THE PLENUM SHALL BE PRESSURIZED TO 144.9 PSIG. THE PLENUM SHALL BE PRESSURIZED TO 183.4 PSIG.

#### PRESSURE SHELL STRESS EVALUATION CRITERIA

THIS CRITERIA ESTABLISHES THE BASIS FOR ANALYSIS AND DESIGN OF THE PRESSURE SHELL SO IT WILL MEET OR EXCEED ALL OF THE REQUIREMENTS OF SECTION VIII, DIVISION 1 OF THE ASME BOILER AND PRESSURE VESSEL CODE AND CAN BE STAMPED WITH A DIVISION 1 "U" STAMP.

##### 1. SECTION VIII, DIVISION 1, DIRECT APPLICATION

(A) THE MAXIMUM ALLOWABLE STRESS (S)

$$S = 18.2 \text{ KSI } (-320^{\circ}\text{F TO } +150^{\circ}\text{F})$$

$$S = 17.7 \text{ KSI } (-320^{\circ}\text{F TO } +200^{\circ}\text{F})$$

(B) PRIMARY BENDING PLUS PRIMARY MEMBRANE STRESSES

THE LOCAL MEMBRANE STRESSES ARE NOT GENERALLY CONSIDERED IN SECTION VIII, DIVISION 1 DESIGNS. HOWEVER, FOR THE PURPOSE OF DESIGNING LOCAL REINFORCEMENT AT BRACKETS, RINGS OR PENETRATIONS NOT COVERED BY DESIGN BASED ON STRESS ANALYSIS, THE LOCAL SHELL MEMBRANE STRESS SHALL BE:

$$P_b + P_m \leq 1.5 SE$$

NOTE: E IS JOINT EFFICIENCY

2. IN REGIONS OF THE PRESSURE SHELL WHERE DIVISION 1 DOES NOT CONTAIN RULES TO COVER ALL DETAILS OF DESIGN (REF. U-2(g)), ADDITIONAL ANALYSES WERE PERFORMED UTILIZING THE GUIDELINES OF THE ASME CODE, SECTION VIII, DIVISION 2, APPENDIX 4, "DESIGN BASED ON STRESS ANALYSIS." THE BASIC STRESS CRITERIA FOR DIVISION 2 IS REPRESENTED IN FIGURE 4-130.1 AND RESTATED BELOW INDICATING ANY MODIFICATIONS OR EXCESS REQUIREMENTS APPLIED TO IT TO REMAIN WITHIN THE INTENT OF DIVISION 1 AND TO OBTAIN A DIVISION 1 STAMP.

A. GENERAL PRINCIPAL MEMBRANE STRESS

MAXIMUM ALLOWABLE STRESS

$$S = 18.2 \text{ KSI } (-320^{\circ}\text{F TO } +150^{\circ}\text{F})$$

$$S = 17.7 \text{ KSI } (-320^{\circ}\text{F TO } +200^{\circ}\text{F})$$

MAXIMUM ALLOWABLE STRESS INTENSITY

$$S_m = 20.0 \text{ KSI } (-320^{\circ}\text{F TO } +300^{\circ}\text{F})$$

B. PRIMARY GENERAL MEMBRANE STRESS INTENSITY

$$P_m \leq S_m$$

AND IN ORDER TO COMPLY WITH DIVISION 1, THE MAXIMUM PRINCIPAL MEMBRANE STRESS MUST BE:

$$P_m^* \leq S$$

NOTE: THE \* IS USED TO DENOTE THAT MAXIMUM PRINCIPAL STRESSES ARE TO BE COMPUTED FOR THE GIVEN LOADING CONDITION. THE INTENT IS TO DETERMINE THE STRESSES WHICH REPRESENT THE HOOP STRESSES AND MERIDIONAL STRESSES WHICH ARE THE STRESSES USED IN DIVISION 1 COMPUTATIONS.

C. DESIGN LOADS, PRIMARY LOCAL MEMBRANE STRESS INTENSITY

$$P_L \leq 1.5 S_m$$

NOTE: LOCAL MEMBRANE STRESS INTENSITY IS DEFINED IN ACCORDANCE WITH DIVISION 2, APPENDIX 4-112(i). THE TOTAL MERIDIONAL LENGTH IS CONSIDERED TO BE  $1.0 \sqrt{RT}$ .

D. DESIGN LOADS, PRIMARY LOCAL MEMBRANE PLUS PRIMARY BENDING STRESS INTENSITY

$$P_L + P_b \leq 1.5 S_m$$

E. OPERATING LOADS, PRIMARY PLUS SECONDARY STRESS INTENSITY

$$P_L + P_b + Q \leq 3 S_m$$

3. A FATIGUE ANALYSIS WAS CONDUCTED IN ACCORDANCE WITH SECTION VIII, DIVISION 2 WITHOUT MODIFICATION.

4. HYDROSTATIC TEST CONDITION DESIGN CONSIDERATIONS

A. PRESSURE SHELL

IN ACCORDANCE WITH DIVISION 1 OF THE ASME CODE, DESIGN ANALYSIS OF THE PRESSURE SHELL FOR THE HYDROSTATIC TEST CONDITION IS NOT REQUIRED. HOWEVER, IN ORDER TO PROVIDE A SATISFACTORY ENGINEERING DESIGN FOR THE PRESSURE SHELL SPECIAL EMPHASIS WAS GIVEN, AS PROMPTED BY NOTE (1) OF SECTION VIII, DIVISION 1 OF THE ASME CODE, TO FLANGES OF GASKETED JOINTS OR OTHER APPLICATIONS WHERE SLIGHT AMOUNTS OF DISTORTION CAN CAUSE LEAKAGE OR MALFUNCTION. EXAMPLES OF THESE AREAS ARE THE PLENUM, PLENUM ACCESS DOORS, PLENUM ACCESS DOOR REINFORCEMENT, THE BULKHEADS, AND BULKHEAD FLANGES.

B. SUPPORT RINGS

DESIGN OF THE PRESSURE SHELL SUPPORT RINGS, INCLUDING



THE CORNER RINGS, FOR THE HYDROSTATIC TEST CONDITION, COMPLIES WITH THE FOLLOWING:

- (A) THE COMBINED VALUE OF THE SHELL CIRCUMFERENTIAL PRESSURE STRESS,  $S_1$  AND SHELL

BENDING STRESS  $S_2$ , RESULTING FROM ACTION OF A

PORTION OF THE SHELL AS AN INNER FLANGE OF THE RING, SHALL NOT EXCEED 0.8 WELD YIELD STRESS:

$$S_1 + S_2 \leq 0.8 \text{ WELD YIELD STRESS,}$$

WHERE, FOR SUPPORT RINGS NOT ANALYZED BY FINITE ELEMENT TECHNIQUES,

$$S_1 = P_H \left( \frac{R}{T} \right) + .6 P_H; P_H \text{ INCLUDES HYDROSTATIC HEAD CORRECTION, AND}$$

$S_2$  = RING BENDING STRESS AT INNER FLANGE, BASED

ON AN EFFECTIVE WIDTH OF THE PRESSURE SHELL ACTING AS AN INNER FLANGE OF THE RING OF 1.1 MULTIPLIED BY THE SQUARE ROOT OF  $D_o T$ .

- (B) THE BENDING STRESS,  $S_{2F}$  ON THE OUTSIDE FLANGE

SHALL NOT EXCEED .9 WELD YIELD STRESS. (IN THE COMPUTER ANALYSIS ALL LOADING CONDITIONS ARE LIMITED TO .9  $S_Y$  ON THE OUTER FLANGE.)

- (C) BRACKETS AND SUPPORT PAD WELDMENTS

THE DESIGN FOR ALL LOADING CONDITIONS INCLUDING THE HYDROSTATIC TEST CONDITION OF THOSE PORTIONS OF BRACKETS AND SUPPORT PAD WELDMENTS WHICH ARE ATTACHED TO THE PRESSURE SHELL BUT NOT ON THE SURFACE OF THE SHELL SHALL COMPLY WITH THE REQUIREMENTS OF THE AISC CODE, I.E. MAXIMUM STRESS IN TENSION EQUALS .6  $S_Y$ , ETC.

Vol. 35

Finite Element Analyses of Plenum  
 Region Including the Side Access  
 Reinforcement, Side Access Door  
 and Angle of Attack Penetration

Table of Contents

Part 1 Plenum

	PAGE NO
Model Description	1
Boundary Condition	5
Loading	8
Combined Door & Plenum Analyses	9
Results	10
Relative displacement between sealing surfaces of Door & Plenum	
$P = 119 \text{ psig}$	11
$P = -15 \text{ psig}$	13

# Vol 3S Table of Contents con't.

## Stress Summary

Region around 9'x12' opening	15
Region around 8.3' dia circular opening	25

Buckling	30
----------	----

Model check points	31
--------------------	----

Figures 1- 68

## Part 2 Door

Model Description	1
Boundary Conditions	5
Loading	6
Combined Door & Plenum Analyses	6
Lateral Buckling of Stiffener Bar	12

# Vol 35 Table of Contents con't.

Results 7

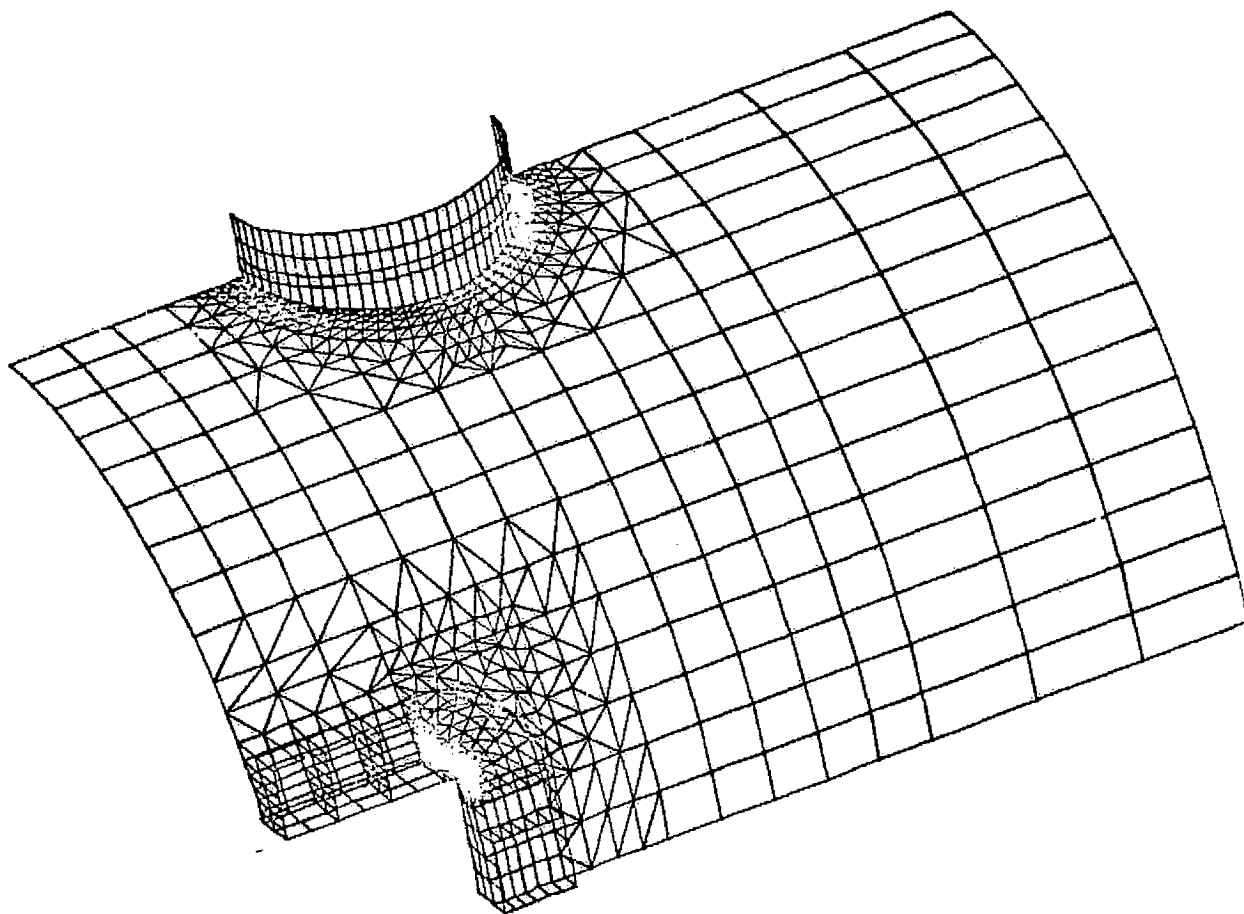
Stress Summary 8

Relative displacement between  
sealing surfaces of Door & Plenum

P = 119 psig 11

P = -15 psig 11

Figures 1A - 71



SPEC  
1.1

NTF 9 X 12 ACCESS OPENING

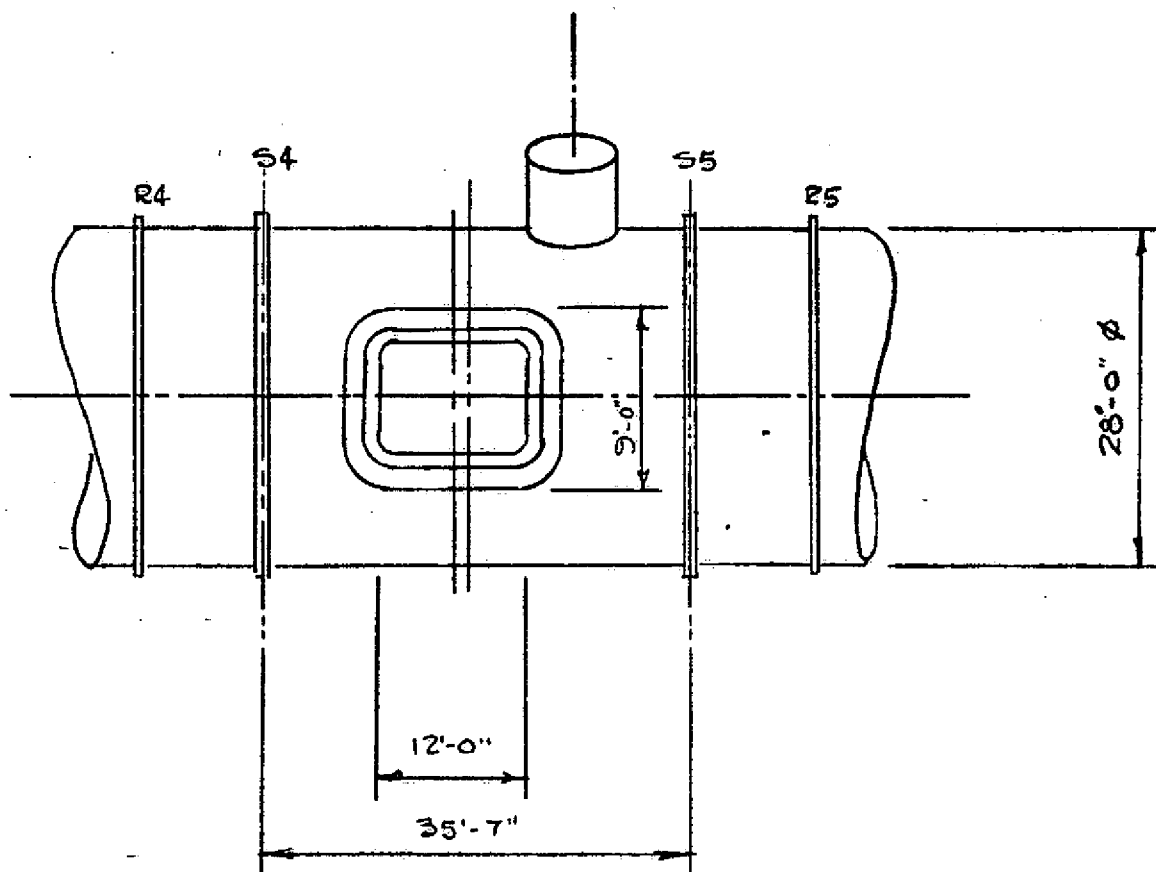
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BY \_\_\_\_\_ DATE \_\_\_\_\_  
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_  
\_\_\_\_\_

SUBJECT UTF SHEET NO. 1 OF \_\_\_\_\_  
FINITE ELEMENT ANALYSES JOB NO. \_\_\_\_\_  
OF ACCESS DOOR REINFORCEMENT

(Plenum)

REFERENCE DRAWING NO. LE-9444319

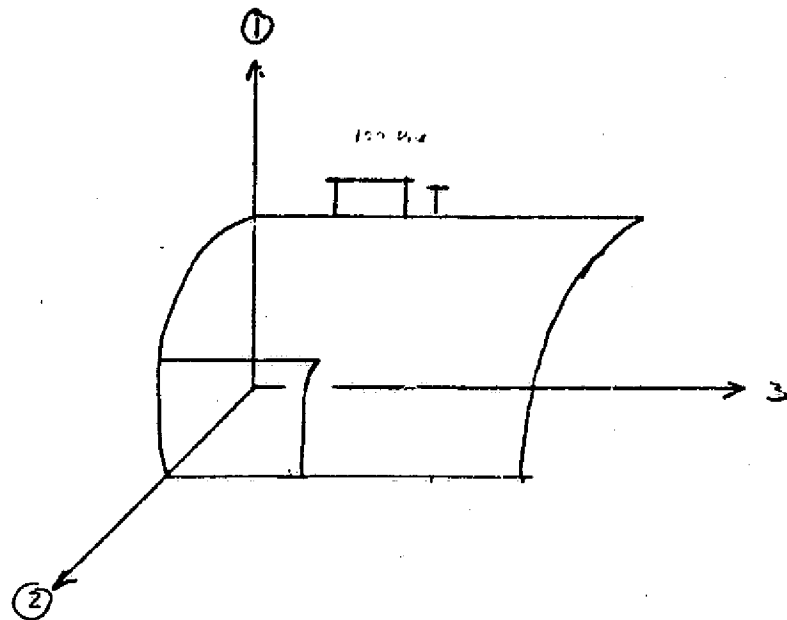


SPAR (a finite element computer code developed & maintained by Engineering Information System, Inc. under NASA contract NAS8-30536 and NAS1-13977) was used to analyse this region of the pressure shell.

The region was modeled using, triangular and quadrilateral, membrane plus bending flat anisotropic elements. The "T" ring & flange was modeled with general beam elements.

A  $90^\circ$  segment of the pressure shell, <sup>(Plenum)</sup> was modeled from the  $\Phi$  of the access opening to beyond the support ring S5. A plane thru the access opening perpendicular to the axis of the shell is a plane of symmetry.

Horizontal & vertical planes thru the axis of the shell are also planes of symmetry.



Plane of symmetry      1-2 plane  
                                      1-3 plane  
                                      2-3 plane

A computer plot of the model is shown in fig 1. The model consist of 1092 joints with 6 DOF per joint except where boundary conditions were applied and rotation about an axis  $\perp$  to a plate element was restricted.

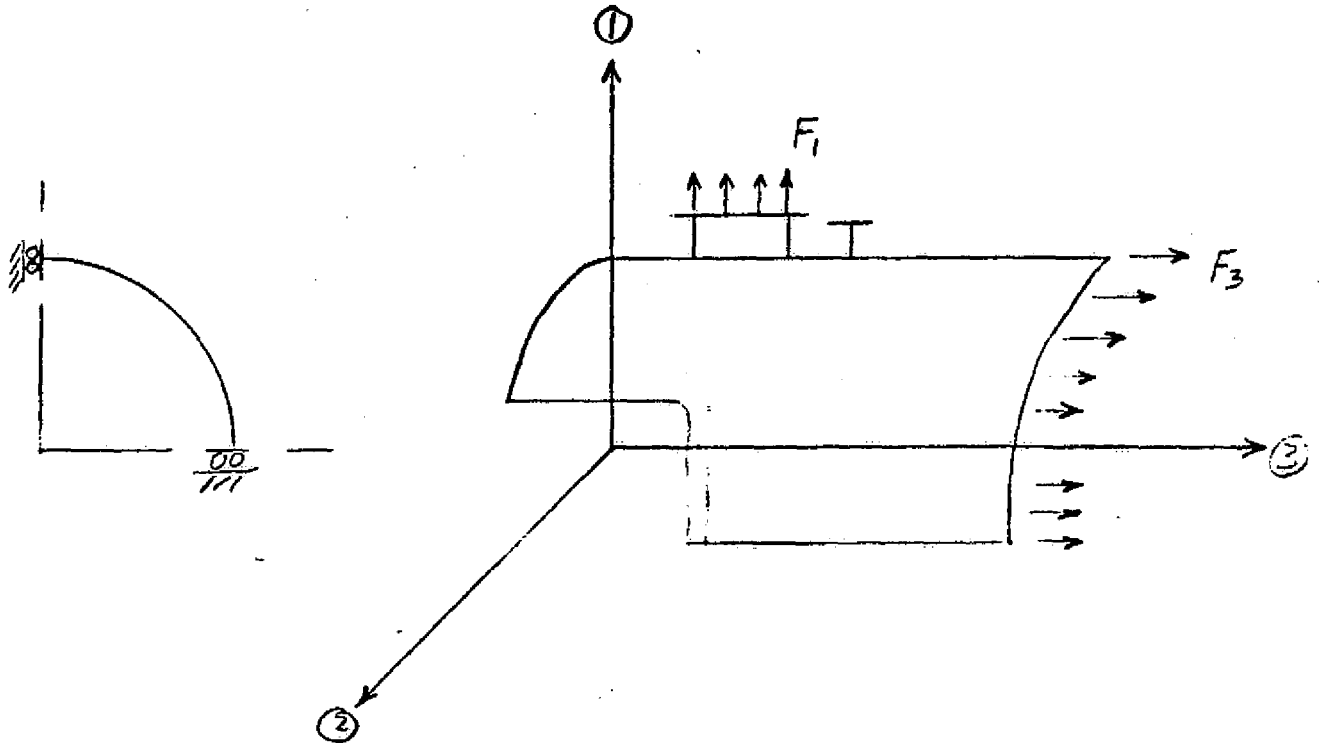


The joint numbers for the model are shown in Fig 2 thru 10

The shell section properties (plate thickness) are shown in Fig 11 thru 19

Shell Section Property	Thickness
1	2.00
2	2.60
3	1.30
4	5.85
5	2.60
6	3.00
7	2.00
8	4.25
9	1.30
10	3.75
11	2.875

## Boundary Conditions



1 2 plane is a plane of symmetry  
 1 3 plane is a plane of symmetry  
 2 3 plane is a plane of symmetry

on boundary of cylinder and pipe - restrict  
 rotation about  $\theta$  &  $z$  axes (cy. coord.)

## Boundary Forces

Cylinder

$$F = (\pi R^2)(P) = \pi (169") (119) = 10677516 \text{ lbs.}$$

For  $\frac{1}{4}$  model

$$F_3 = \frac{F}{4} = 10677516 \text{ lbs.}$$

$$F_3 = 2669379 \text{ lbs.}$$

This force was applied uniformly,  
around  $\frac{1}{4}$  cylinder model

or Joint 1 + 16 - 88979.2 lbs.

- 2 thru 15 - 177957.3 lbs.

Pipe

$$F = (\pi R^2)(P) = \pi (50^2) 119 = 934623.8 \text{ lbs.}$$

For  $\frac{1}{2}$  model of pipe

$$F_1 = \frac{F}{2} = \frac{934623.8}{2} \text{ lbs}$$

$$F_1 = 467311.9 \text{ lbs.}$$

This force was applied uniformly around  $\frac{1}{2}$  pipe model

Joint 1056 & 1092 - 6490 lb  
 1057 thru 1091 - 12980 lbs

9' X 12' - opening

Forced displacements obtained from combining the Door and Plenum models were applied to the 9' X 12' opening. See discussion on combined runs (p. 9)

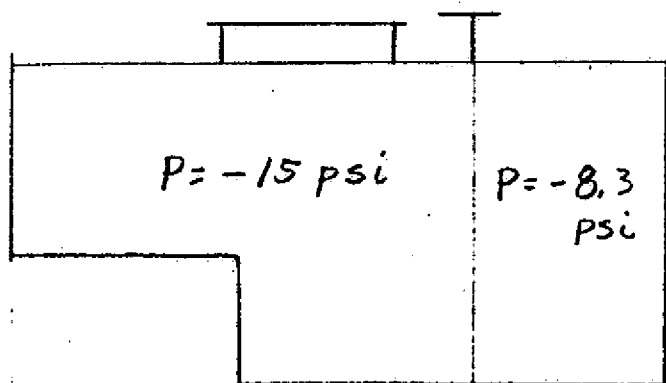
## Loading

### Internal Pressure

$P = 119 \text{ psi}$  ( design pressure ) was applied as nodal pressure to the joints of the pressure surface.

### External Pressure

Nodal pressure was applied to the joints of the pressure surface according to the following sketch.



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## Combined Door & Plenum Analysis

see Finite Element Analyses of Side Access Door

To determine the interaction of the door and plenum, a combined reduced stiffness matrix from the 2 models (Plenum and Door) was generated. From this the relative displacement between the door and plenum <sup>(sealing surfaces)</sup> was determined for internal pressure.

Nodal displacements from the combined run were used as boundary conditions at the sealing surfaces of the Door and Plenum to compute the final stress in each model.

For vacuum condition, the dog loads and relative displacement between the door & plenum (sealing surfaces) was determined.

## Results

Nodal stresses are presented in Fig 20 thru 67.

The max principal stress (PS1) or min principal stress (PS2) are given for the mid-surface (surface 0), the inside surface (surface 1), and outside surface (surface 2).

The stresses plotted are for joint 1 of the element. As an example (reference Fig 2), for the element defined by joints 17, 18, 34, 33 joint 1 for that element is 17.

Nodal stresses for one joint are given from 4 elements (for quadrilateral elements). If any discrepancies exist in the stresses for a joint, the largest value is used in the interpretation of the results.

BY \_\_\_\_\_ DATE \_\_\_\_\_

SUBJECT \_\_\_\_\_

SHEET NO. 11 OF \_\_\_\_\_

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

JOB NO. \_\_\_\_\_

The displacement of the sealing surfaces for the Door and plenum for an internal  $P = 119 \text{ psi}$  is given in table 1.

The sealing surfaces of the Door and Plenum remained in contact. (the relative displacements of the sealing surfaces was minus)



TABLE 1

$P = 119 \text{ psi}$

# CONNECT POINT NO.	DISPLACEMENTS AT SEALING SURFACES		RELATIVE DISPLACEMENTS
	<u>PLENUM</u>	<u>DOOR</u>	
1	.0726	.0736	- .00109
2	.0657	.0666	- .00092
3	.0512	.0521	- .00086
4	.0329	.0329	- .00003
5	.0196	.0197	- .00008
6	.0123	.0128	- .00049
7	.0123	.0126	- .00034
8	.0122	.0127	- .00051
9	.0114	.0118	- .00035
10	.0113	.0115	- .00014

\* SEE FIGURE

ALL RELATIVE DISPLACEMENTS ARE NEGATIVE  
 ∴ ALL POINTS ALONG SEALING SURFACES OF  
 DOOR AND PLENUM REMAIN IN CONTACT.

RELATIVE DISPLACEMENTS X STIFFNESS ( $1.0 \times 10^8$ )  
 RESULTS IN A TOTAL DOOR FORCE OF 480,539 lb.

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The displacement and relative displacement of the sealing surfaces of the Door and Plenum for vacuum conditions (external pressure = 15 psi) are given in table 2.

The dog loads for vacuum conditions are also given in Table 2.

TABLE 2  
 VACUUM PRESSURE

* CONNECT POINT NO.	DISPLACEMENTS AT SEALING SURFACES		RELATIVE DISPLACEMENTS
	<u>PIENUM</u>	<u>DOOR</u>	
1	-.00464	-.0214	.01676
2	-.00386	-.0194	.01550
3	-.00214	-.0155	.01338
4	-.00018	-.0101	.00991
5	.00227	-.0123	.01458
6	.00379	-.0165	.02032
7	.00380	-.0194	.02321
8	.00380	-.0217	.02546
9	.00413	-.0229	.02709
10	.00416	-.0234	.02756

\* SEE FIGURE

CONNECT POINTS 1-4 ARE DOG LOCATIONS  
 AND ARE THE ONLY POINTS CONSIDERED TO  
 BE TIED TOGETHER DURING VACUUM CONDITIONS.

FORCES AT DOGS

* RELATIVE DISPLACEMENT	X DOG STIFFNESS	= FORCE
1 .01676	.63E+6	10558.8 #
2 .01550	.63E+6	9763.1
3 .01338	.63E+6	8430.0
4 .00991	3.21E+6	31820.1

TOTAL = 60572.0 #

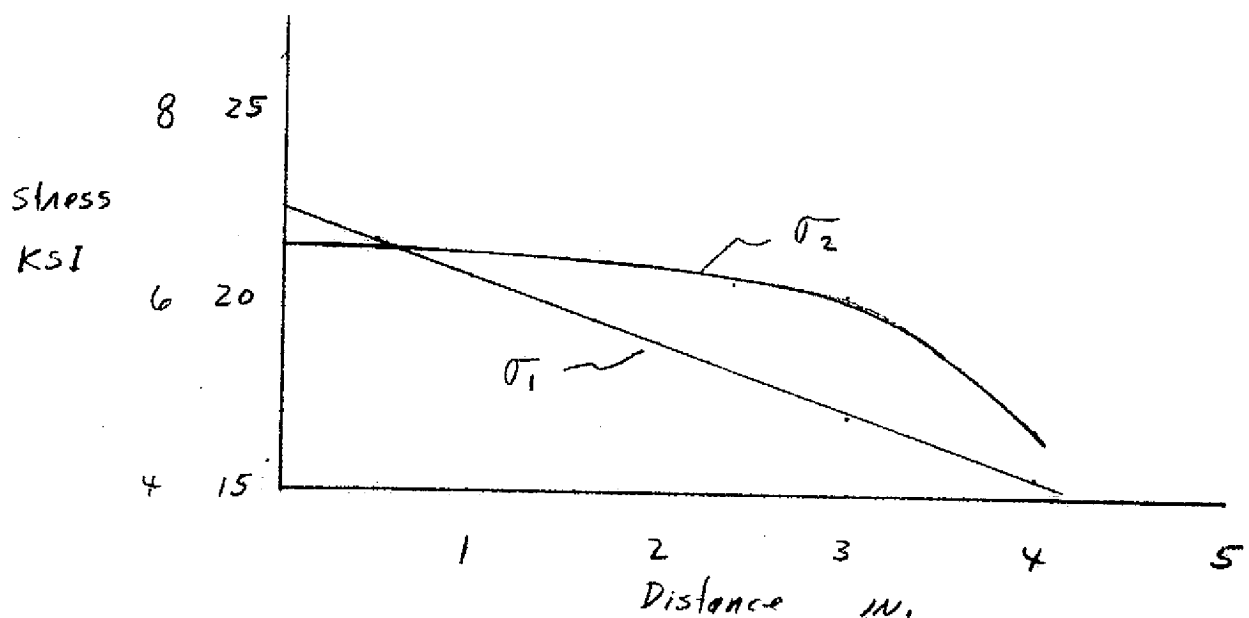
## Region around the 9' x 12' Opening

Max Membrane stress occurs in the corners

See fig. 44.

The max. stress intensity is at group 4 index 17

Since stress for surface 0 is at the centroid of triangular element, the stress is projected to edge of plate



$$\sigma_1 = 22.4 \text{ KSI}$$

$$\sigma_2 = 7.40 \text{ KSI}$$

$$\sigma_3 = -\frac{119}{2} = -0.06 \text{ KSI}$$

$$S_{12} = 22.4 - 7.40 = 15.0 \text{ KSI}$$

$$S_{23} = 7.40 - (-0.06) = 7.46 \text{ KSI}$$

$$S_{31} = -0.06 - 22.4 = -22.46 \text{ KSI}$$

$$P_L = |-22.46| = 22.46 \text{ KSI}$$

$$P_L \leq 1.5 S_m$$

$$22.46 < 1.5(20) = 30 \text{ KSI}$$

This stress is local membrane stress near a nozzle.

∴ The region meets the criteria for Local primary stress intensity

## General Membrane Stress Intensity

away from opening

See fig 20

(1/89/120)

$$\sigma_1 = 10.58 \text{ KSI}$$

$$\sigma_2 = 4.97 \text{ KSI}$$

$$\sigma_3 = -\frac{.119}{2} = -.06 \text{ KSI}$$

$$S_{12} = 10.58 - 4.97 = 5.61 \text{ KSI}$$

$$S_{23} = 4.97 - (-.06) = 5.03 \text{ KSI}$$

$$S_{31} = -.06 - 10.58 = -10.64 \text{ KSI}$$

$$P_m = |-10.64| = 10.64 \text{ KSI}$$

$$P_m \leq S_m$$

$$10.64 < 20 \text{ KSI} \quad \text{O.K.}$$

## General Principle Membrane Stress

$$\sigma_1 = 10.58$$

$$\sigma_1 \leq S$$

$$10.58 < 18.2 \text{ KSI}$$

∴ The general principle membrane stress and the general membrane stress intensity for the plenum region meets the stress evaluation criteria.

Primary Plus Secondary Stress IntensityInside Surface (See Fig 46)

Max stress intensity at

4/20/ 518

To correct for stress at the edge

$$\text{add } 22.4 - 21.55 = .85 \text{ ksi of } \sigma_1$$

$$\text{add } 7.4 - 7.4 = 0 \text{ of } \sigma_2$$

$$\sigma_1 = 32.4 + .85 = 33.25 \text{ ksi}$$

$$\sigma_2 = 16.7 + 0 = 16.7 \text{ ksi}$$

$$\sigma_3 = -.119 \text{ ksi}$$

$$S_{12} = 33.25 - 16.7 = 16.55 \text{ ksi}$$

$$S_{23} = 16.7 - (-.12) = 16.82 \text{ ksi}$$

$$S_{31} = -.12 - 33.25 = -33.37 \text{ ksi}$$



$$P_L + P_b + Q = |-33.37| = 33.37 \text{ KSI}$$

$$P_L + P_b + Q \leq 35m$$

$$33.37 < 3(20) = 60 \text{ KSI} \quad \text{O.K.}$$

### Outside Surface

See Fig 45

Max at. 4/16 / 518

Apply same correction as before

$$\sigma_1 = 18.98 + 0.85 = 19.83 \text{ KSI}$$

$$\sigma_2 = -.37 + 0 = -.37 \text{ KSI}$$

$$\sigma_3 = 0$$

$$S_{12} = 19.83 - (-.37) = 20.20 \text{ KSI}$$

$$S_{23} = -.37 - 0 = -.37 \text{ KSI}$$

$$S_{31} = 0 - 19.83 = -19.83 \text{ KSI}$$

$$P_L + P_b + Q = |20.20| = 20.20 \text{ KSI}$$

$$P_L + P_b + Q \leq 3 S_m$$

$$20.20 < 3(20) = 60 \text{ KSI} \quad \text{o.k.}$$

The primary plus secondary stress intensity for the region around the 9' x 12' opening meets the stress evaluation criteria.

# Inside Stiffener Ring

See Fig 32 and 38

Max at 6136/591

Membrane stress

$$\sigma_1 = 19.80 \text{ KSI}$$

$$\sigma_2 = -4.15 \text{ KSI}$$

$$\sigma_3 = -\frac{1.19}{2} = -.06 \text{ KSI}$$

$$S_{12} = 19.80 - (-4.15) = 23.95 \text{ KSI}$$

$$S_{23} = -4.15 - (-.06) = 4.09 \text{ KSI}$$

$$S_{31} = -.06 - 19.80 = -19.86 \text{ KSI}$$

$$P_L = |23.95| = 23.95 \text{ KSI}$$

$$P_L \leq 1.5 S_m$$

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JOB NO. \_\_\_\_\_

$$23.95 < 1.5(20) = 30 \text{ KSI}$$

O.K.

The stress is local stress at  
a nozzle

∴ This region meets the criteria  
for local membrane stress intensity.

## Primary plus Secondary Stress Intensity

The max stress intensity is on  
the non-pressure side of the  
inside stiffener See Fig. 36 + 42

$$\sigma_1 = 5.66 \text{ KSI}$$

6/38/582

$$\sigma_2 = -21.12 \text{ KSI}$$

$$\sigma_3 = 0 \text{ KSI}$$

$$S_{12} = 5.66 - (-21.12) = 26.78 \text{ KSI}$$

$$S_{23} = -21.12 - 0 = -21.12 \text{ KSI}$$

$$S_{31} = 0 - 5.66 = 5.66 \text{ KSI}$$

$$P_L + P_b + Q = |26.78| = 26.78 \text{ KSI}$$

$$P_L + P_b + Q \leq 3 S_m$$

$$26.78 < 3(20) = 60 \text{ KSI}$$

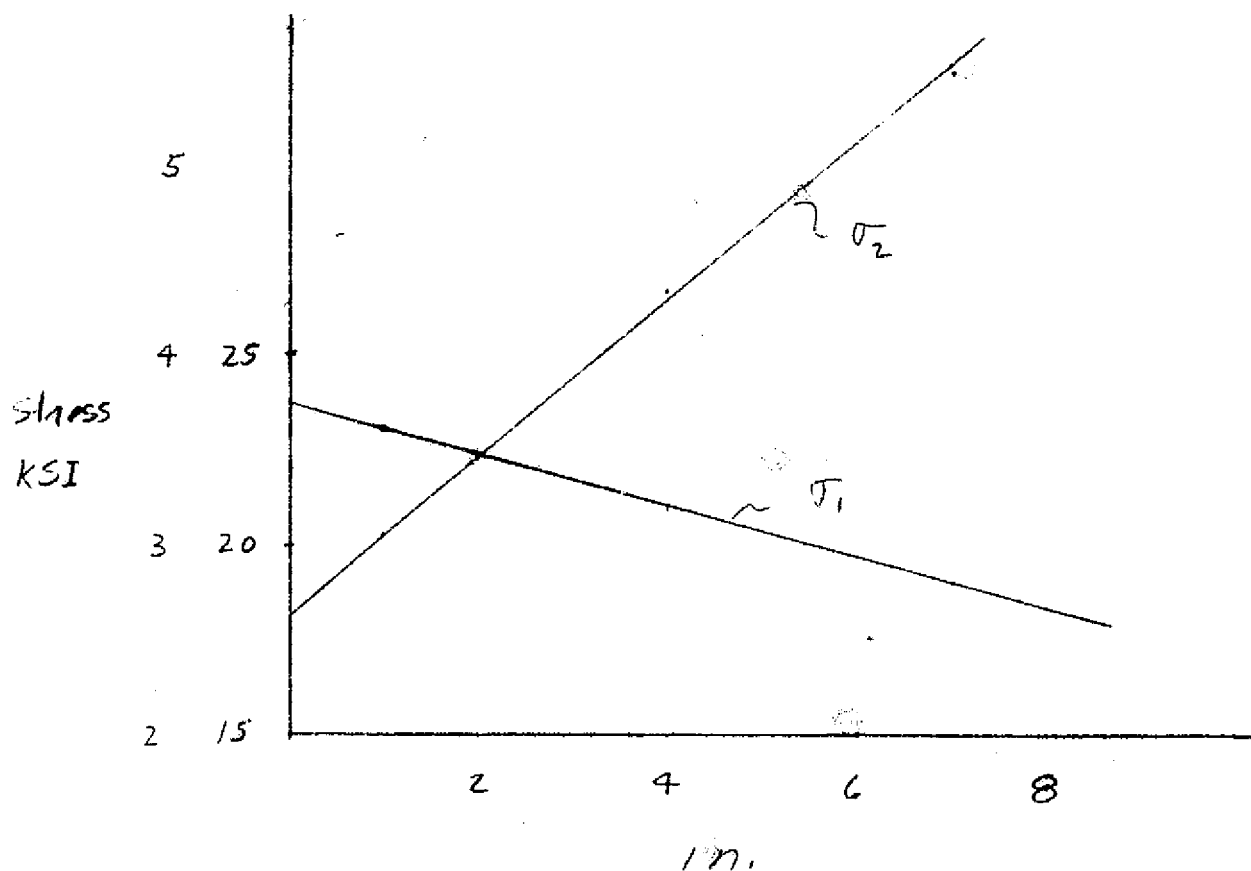
∴ This region meets the criteria for  
primary plus secondary stress intensity

## Region the 8.33' dia circular hole

Ref. Fig. 50

Max membrane stress intensity at  
6/71

Since stress at surface 0 is for centroid of triangular element, the stress is projected to edge of plate.



$$\sigma_1 = 23.8 \text{ KSI}$$

$$\sigma_2 = 2.62 \text{ KSI}$$

$$\sigma_3 = -\frac{119}{2} = -0.06 \text{ KSI}$$

$$S_{12} = 23.8 - 2.62 = 26.42 \text{ KSI}$$

$$S_{23} = 2.62 - (-0.06) = 2.68 \text{ KSI}$$

$$S_{31} = -0.06 - 23.8 = -22.86 \text{ KSI}$$

$$P_L = |-22.86| = 22.86 \text{ KSI}$$

$$P_L \leq 1.5 S_m$$

$$22.86 < 1.5(20) = 60 \text{ KSI} \quad \text{O.K.}$$

This stress intensity is local stress intensity near a nozzle

∴ This region meets the criteria for local membrane stress intensity

Primary Plus Secondary Stress Intensity

Outside Surface ref. Fig. 51

Max at 6/71/795

To correct for stresses at  
edge of plate

$$\text{add } 23.8 - 23.13 = .67 \text{ KSI}$$

$$\text{add } 2.62 - 3.03 = -.41 \text{ KSI}$$

$$\sigma_1 = 24.21 + .67 = 24.88 \text{ KSI}$$

$$\sigma_2 = 12.85 + (-.41) = 12.43 \text{ KSI}$$

$$\sigma_3 = 0$$

$$S_{12} = 24.88 - 12.43 = 12.43 \text{ KSI}$$

$$S_{23} = 12.43 - 0 = 12.43 \text{ KSI}$$

$$S_{31} = 0 - 24.88 = -24.88 \text{ KSI}$$



$$P_L + P_b + Q = |-24.88| = 24.88 \text{ KSI}$$

$$P_L + P_b + Q \leq 3 S_m$$

$$24.88 < 3(20) = 60 \text{ KSI} \quad \text{O.K.}$$

Inside Surface

6/71/795

See Fig. 52

To correct stress for edge of plate,  
apply the same correction as above.

$$\sigma_1 = 22.62 + 0.64 = 22.62 \text{ KSI}$$

$$\sigma_2 = -8.85 + (-1.42) = -9.27 \text{ KSI}$$

$$\sigma_3 = 0$$

$$S_{12} = 22.62 - (-9.27) = 31.89 \text{ KSI}$$

$$S_{23} = -9.27 - 0 = -9.27 \text{ KSI}$$

$$S_{31} = 0 - 22.62 = -22.62 \text{ KSI}$$

$$P_L + P_b + Q = |31.89| = 31.89 \text{ KSI}$$

$$P_L + P_B + Q < 3S_m$$

$$31.89 < 3(20) = 60 \text{ KSI} \quad \text{O.K.}$$

∴ The primary plus secondary stress intensity for this region meets the stress evaluation criteria.

The holes size in this analyses is 8.33' dia. The thickness of the reinforcement around the hole is 3.75. The hole shown on drawing LE 944429S is 6.0' dia. The thickness of the reinforcement around the hole is 4.25.

Since the larger dia & smaller reinforcing thickness meets the stress evaluation criteria, the 6.0' dia hole was not analysed. It was assumed to also meet the criteria

## Buckling of Plenum

A finite element analysis for the 304 S.S. design was not performed. The thicknesses are greater than the 9% Ni. design with only slight change in Mod. of elasticity ( $28 \times 10^6$  psi for 304 vs  $29 \times 10^6$  for 9% Ni)

The critical load factor for 304 S.S. will be larger than 9% Ni design

From 9% Ni analysis

The critical load factor for plenum region at a pressure of -15 psi is 12.0.

Buckling occurred at the center of the plenum.

See Fig 69

Model check points

axial & hoop stress in section of shell

$$S_H = \frac{Pr}{t} = \frac{(119)(169)}{1.3} = 15.47 \text{ KSI}$$

$$S_a = \frac{Pr}{2t} = \frac{(119)(169)}{2(1.3)} = 7.73 \text{ KSI}$$



Stress at surface O

$$S_1 = 15.32 \text{ KSI}$$

$$S_2 = 7.76 \text{ KSI}$$

∴ stresses on section of cylinder check with hand calculations

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SHEET NO. 52 OF \_\_\_\_\_

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Model check - Buckling

Ref. Theory of Elastic Stability  
Timoshenko & Gere  
Second Edition  
p. 495 to 497

Buckling under Combined Axial and  
Uniform Lateral Pressure

Assume shell to be simply supported.  
and a uniform cylinder with  
 $t = 1.75$      $R = 168.875"$      $L = 427"$   
 $E = 29 \times 10^6$  psi     $\mu = 0.3$

The critical pressure is 122.5 psi

The critical load factor for  
15 psi is 8.2

Ref: Stress in Shell  
W. Flügge  
Second Printing  
p. 432 to 434

For External Pressure only

Assume edges clamped and  
a uniform cylinder with  $t = 1.75$

$R = 168.75$      $L = 477"$      $E = 29 \times 10^6 \text{ psi}$

$\mu = 0.3$

The critical pressure is 123.9 psi.

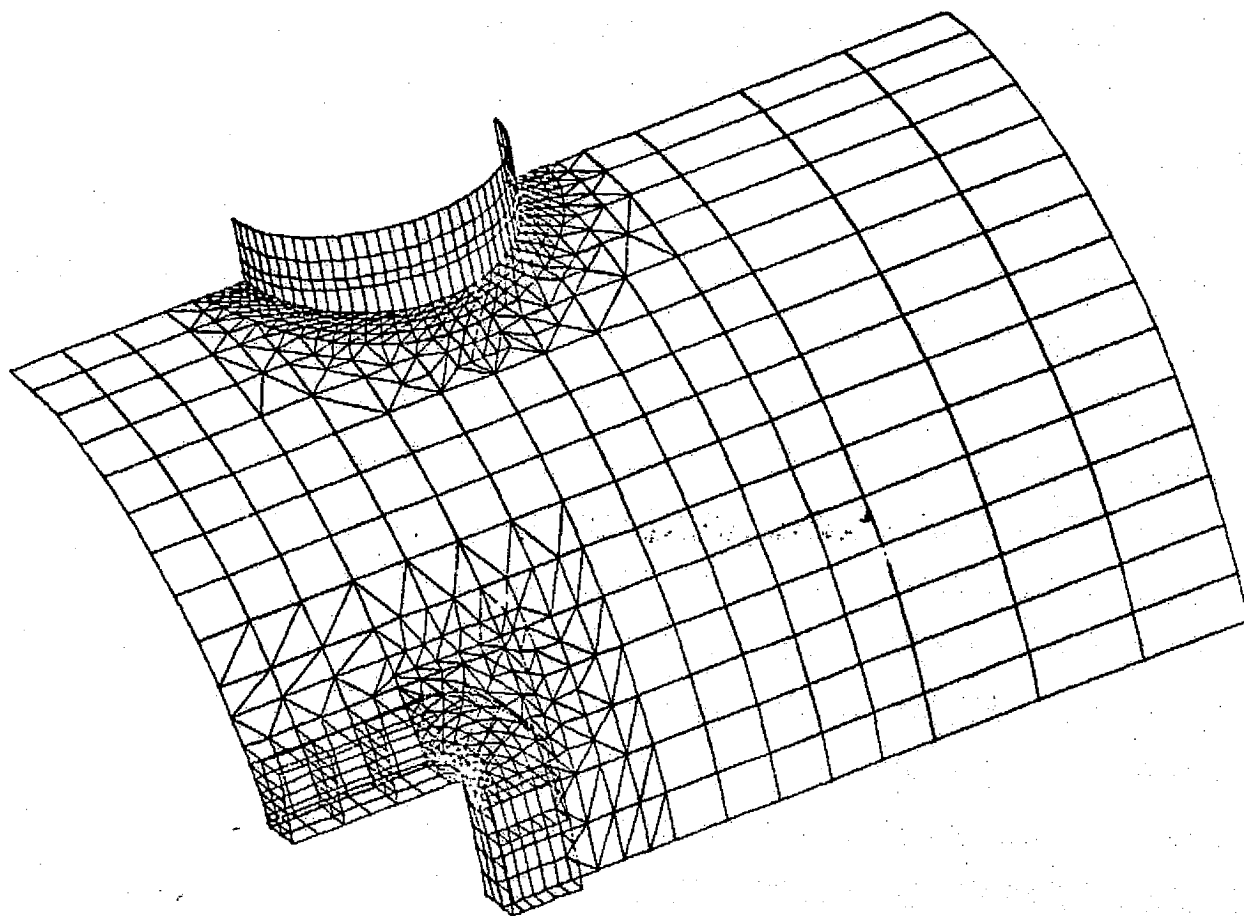
The critical load factor for

15 psi is 8.3

Timoshenk & Flügge yield critical  
load factor lower than the  
finite element solution (8.3 vs 12.0)

This can be explain by the  
fact part of the shell in the  
finite element solution is 2" thick  
and the heavy reinforcing provided  
around the openings.

∴ Model is O.K.



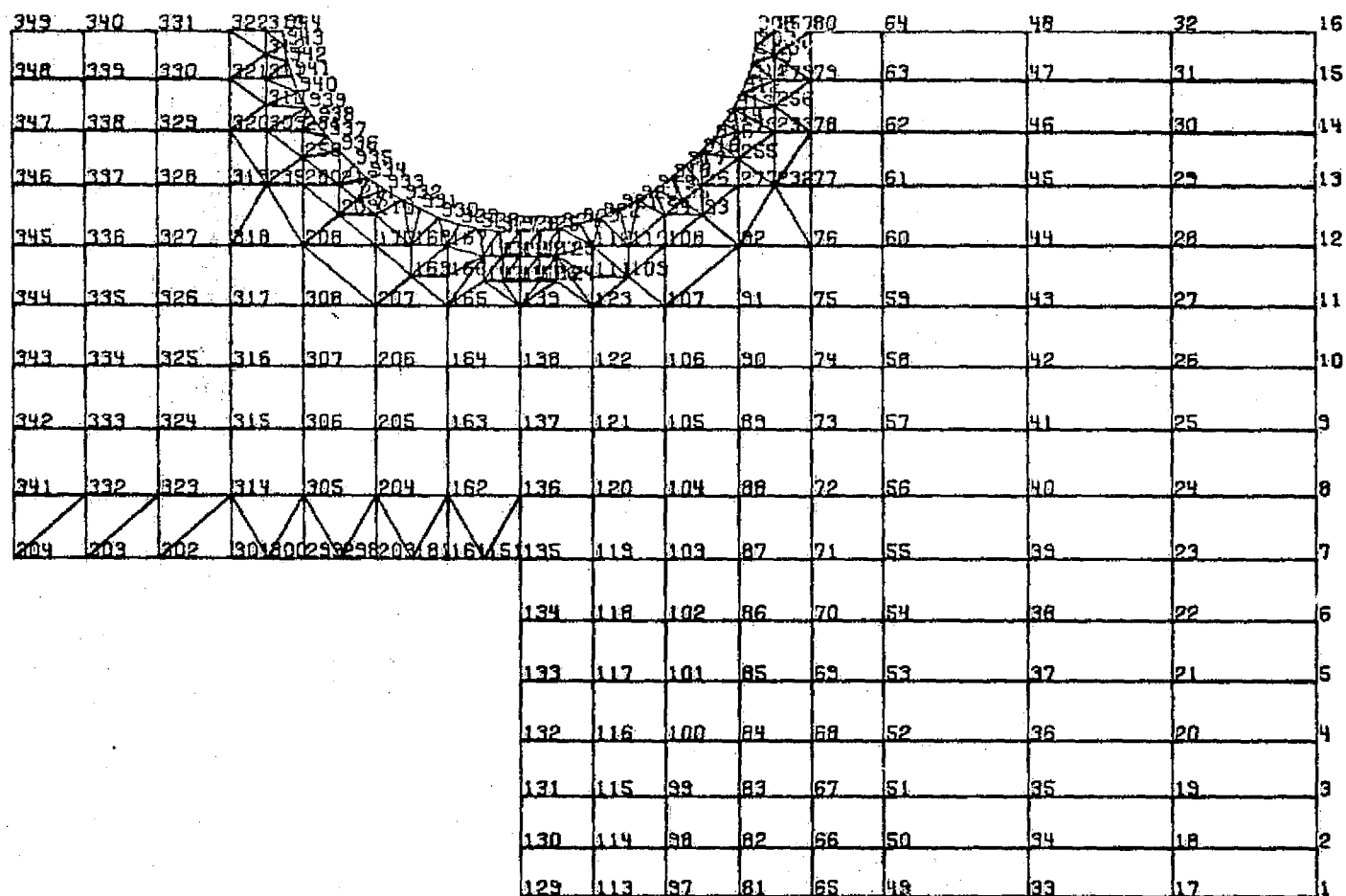
REPRODUCIBILITY OF THE  
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SPEC  
1.1

NTF 9 X 12 ACCESS OPENING

0 64  
SCALE

Figure 1





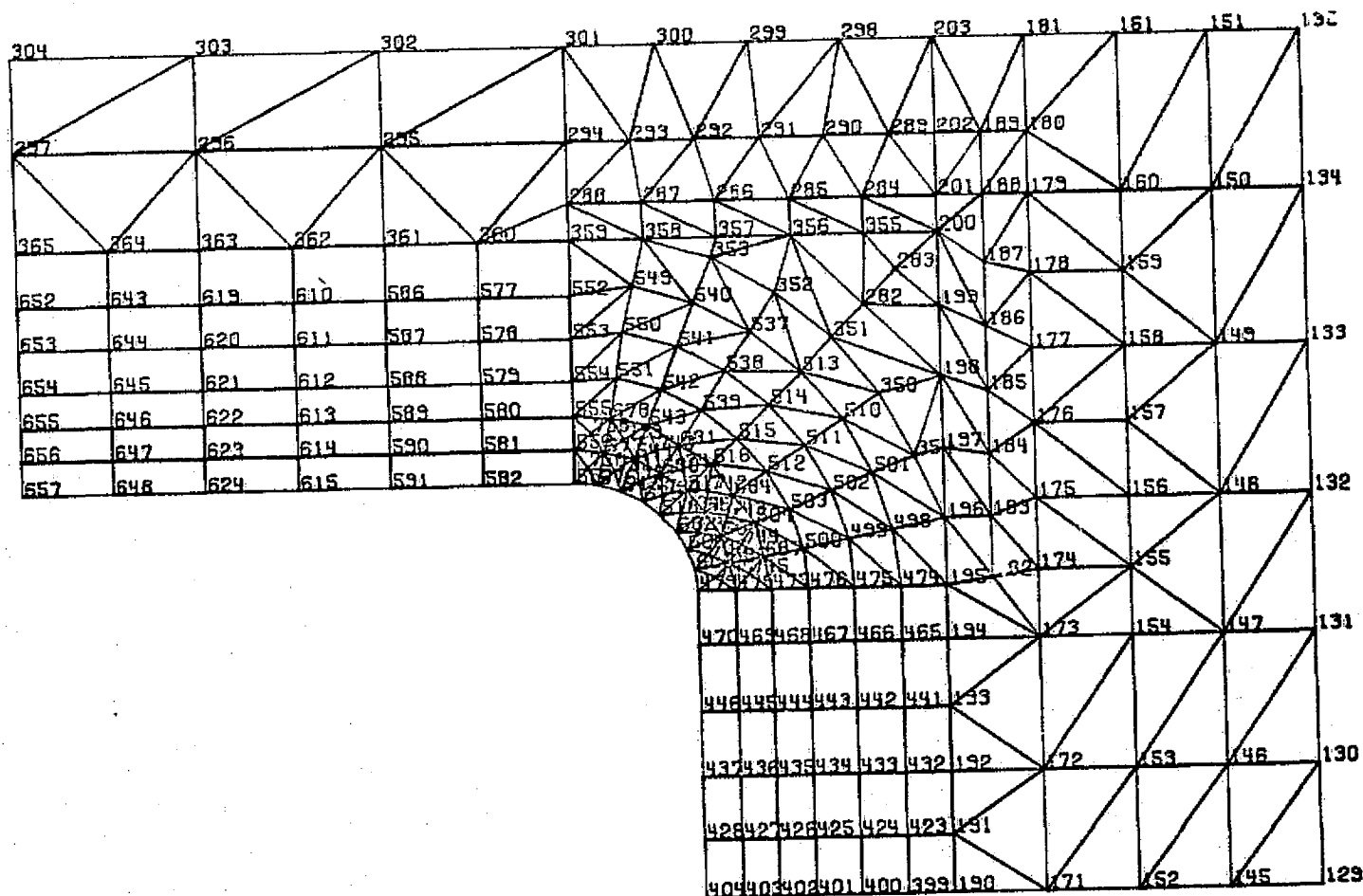
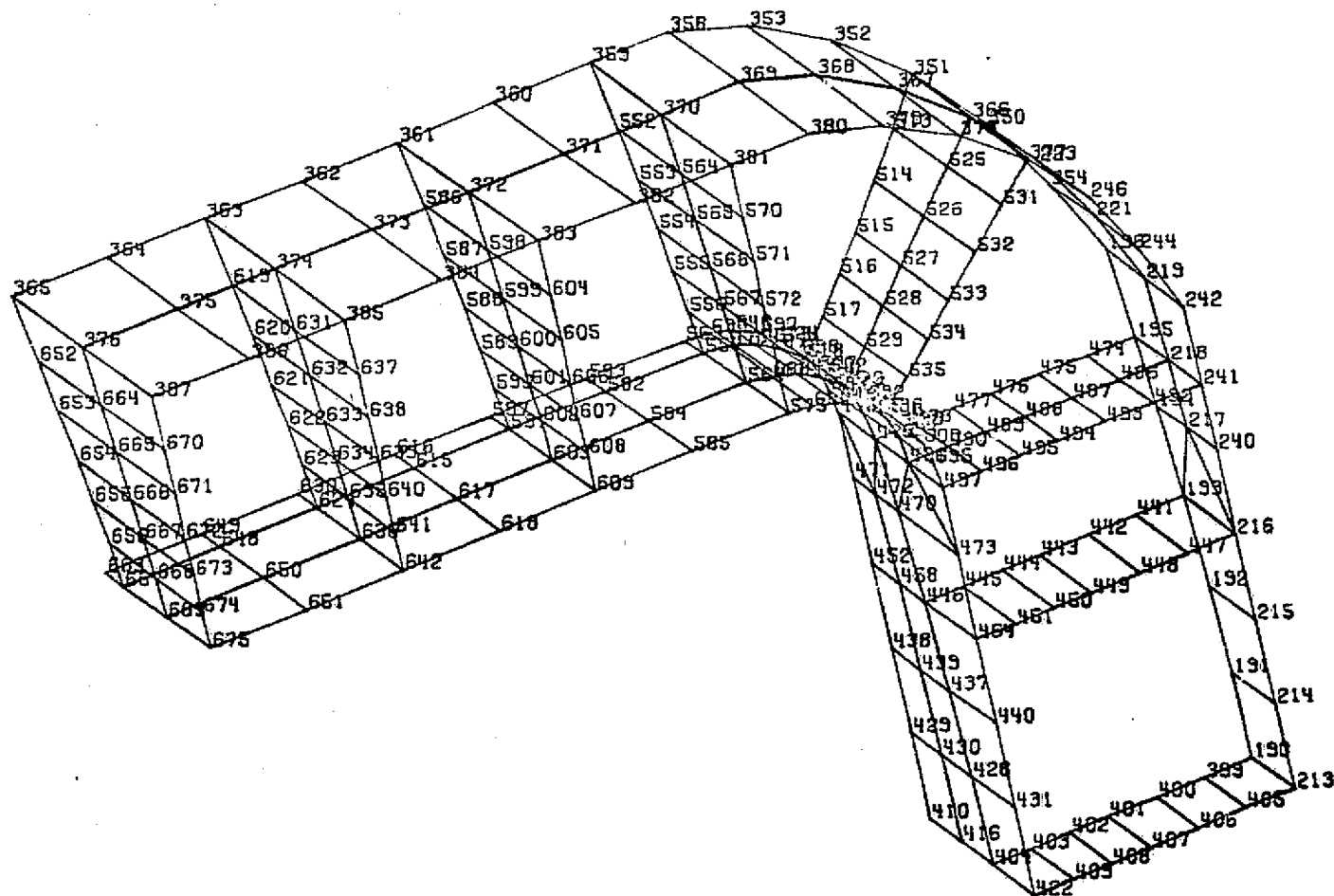


Figure 4



SPEC  
5.1

NTF 9X12 ACCESS OPENING  
GUSSET

0 18  
SCALE

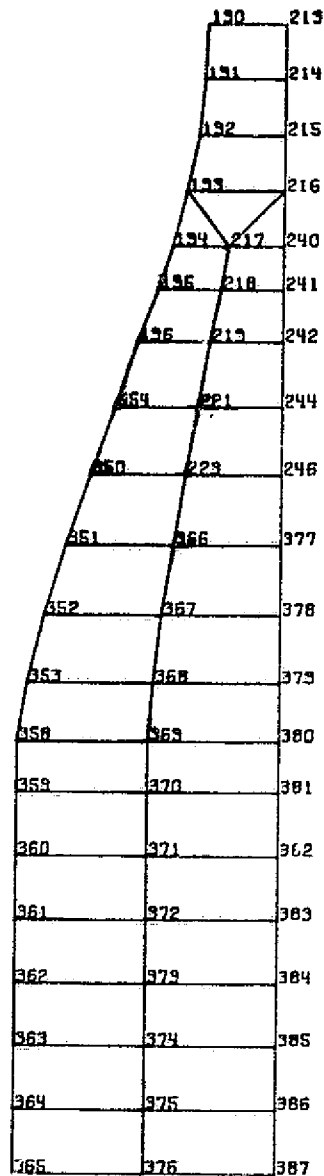
410	416	404	422
423	430	428	431
438	433	437	440
452	458	446	464
471	472	470	473
485	479	491	497
503	505	504	505
507	506	508	509
528	522	522	533
524	518	530	536
537	573	530	531
546	546	547	548
596	576	582	583
563	557	569	576
583	582	584	586
597	591	593	593
616	615	617	618
630	624	636	642
643	648	650	651
663	657	669	676

SPEC  
6.1

NTF 9X12 REINF.  
INNER RING

0 SCALE

Figure 5



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SPEC  
7.1

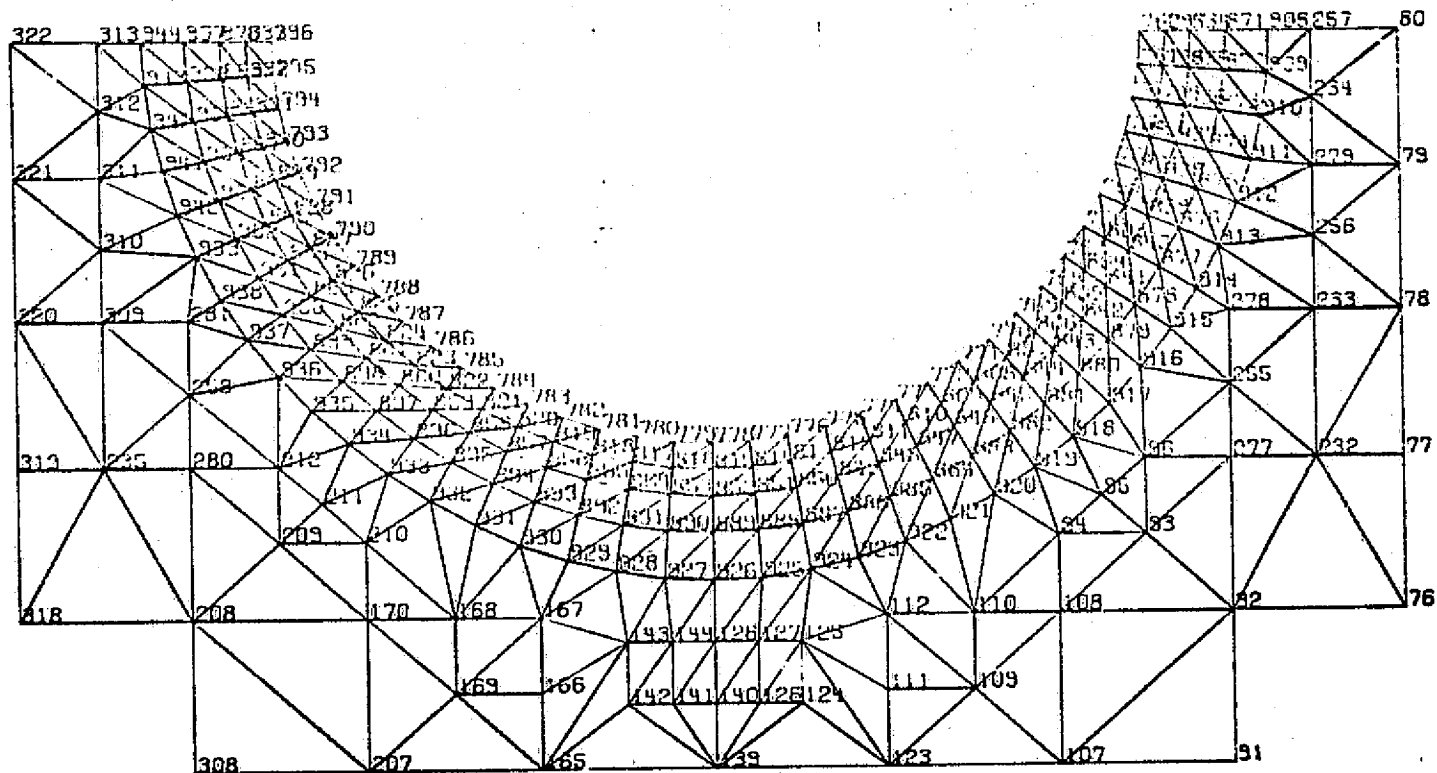
NTF 9X12 DOOR REINF.  
OUTER RING

0 19  
SCALE

Figure 6



Figure 8



SPEC  
9.1

9 X 12 REINF WITH 9 FT HOLE  
TRIANGLES AROUND 9 FT HOLE

0 24  
SCALE

1074	1073	1072	1071	1070	1069	1068	1067	1066	1065	1064	1063	1062	1061	1060	1059	1058	1057	1056
1037	1036	1035	1034	1033	1032	1031	1030	1029	1028	1027	1026	1025	1024	1023	1022	1021	1020	1019
1000	999	998	997	996	995	994	993	992	991	990	989	988	987	986	985	984	983	982
963	962	961	960	959	958	957	956	955	954	953	952	951	950	949	948	947	946	945
778	777	776	775	774	773	772	771	770	769	768	767	766	765	764	763	762	761	760

Figure 9

SPEC  
10.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 1

0 SCALE 11

1092	1091	1090	1089	1088	1087	1086	1085	1084	1083	1082	1081	1080	1079	1078	1077	1076	1075	1074
1055	1054	1053	1052	1051	1050	1049	1048	1047	1046	1045	1044	1043	1042	1041	1040	1039	1038	1037
1018	1017	1016	1015	1014	1013	1012	1011	1010	1009	1008	1007	1006	1005	1004	1003	1002	1001	1000
981	980	979	978	977	976	975	974	973	972	971	970	969	968	967	966	965	964	963
796	795	794	793	792	791	790	789	788	787	786	785	784	783	782	781	780	779	778

Figure 10

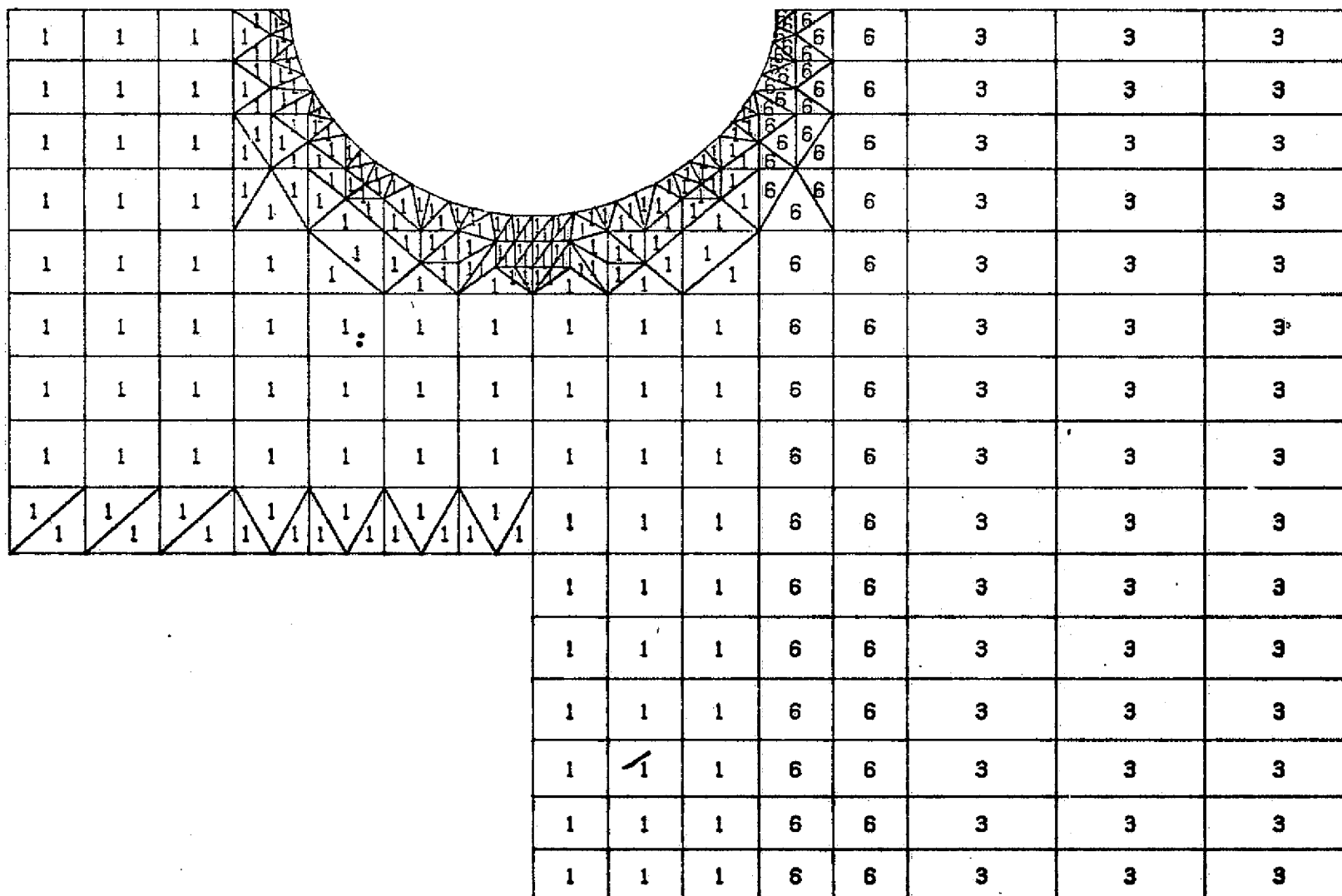
SPEC  
11.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 2

0 SCALE 11



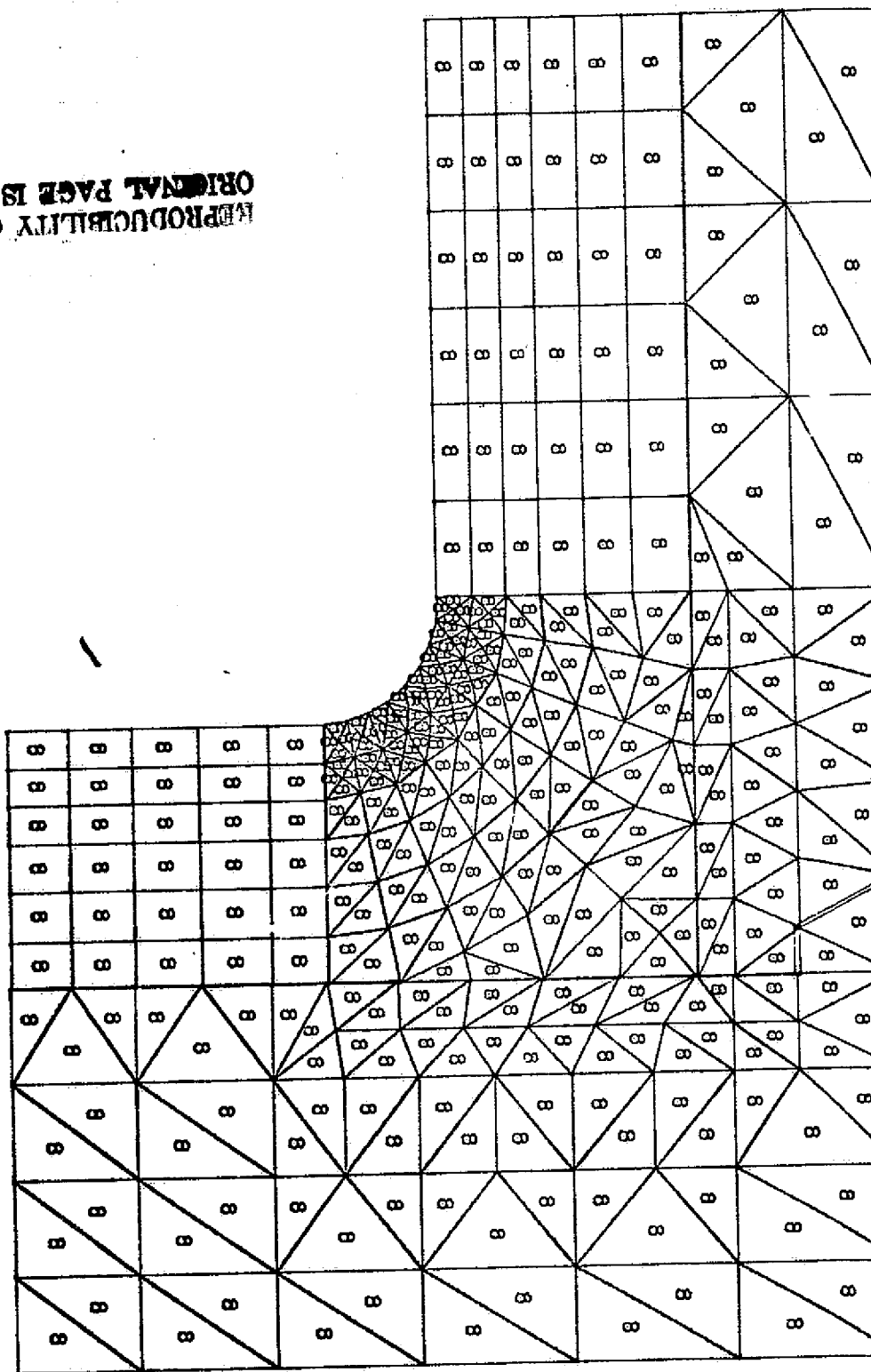
Figure 11



ELEMENT SECTION PROPERTY GROUPS

Figure 12

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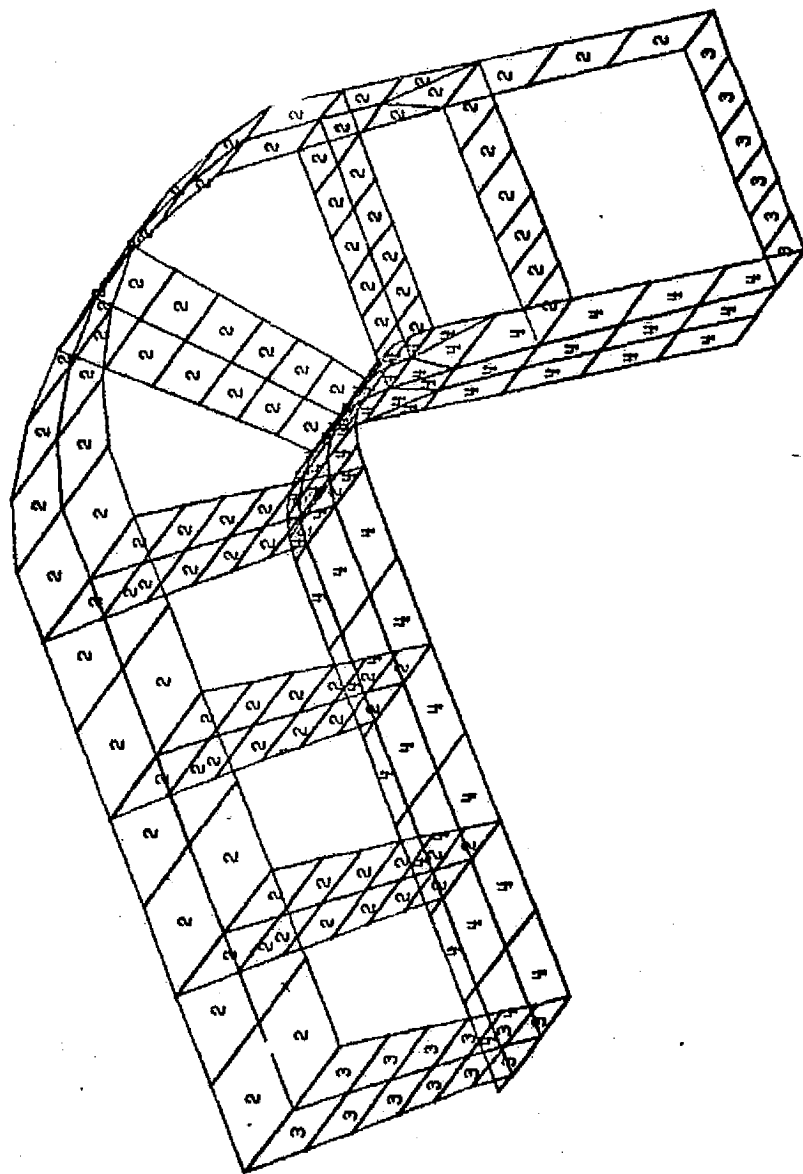


SPEC  
4.1

NTF 9 X 12 ACCESS OPENING  
SHELL

0  
SCALE

ELEMENT SECTION PROPERTY GROUPS



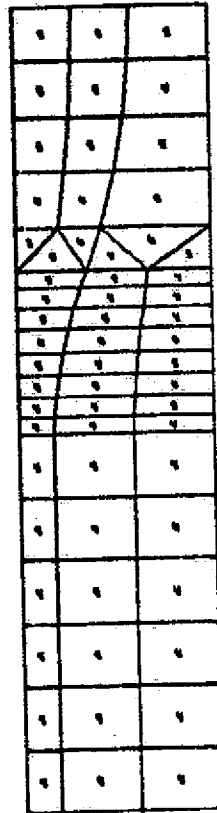
0 SCALE 18

NTF 9X12 ACCESS OPENING  
GUSSET

SPEC  
5.1

PROPERTY GROUPS

Figure.13

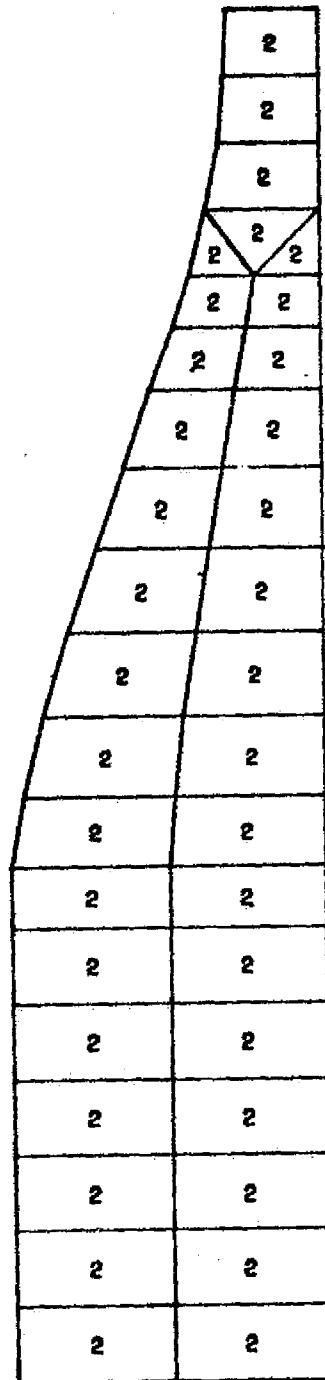


SPEC  
6.1

NTF 9X12 REINF.  
INNER RING

0 SCALE 14

Figure 14



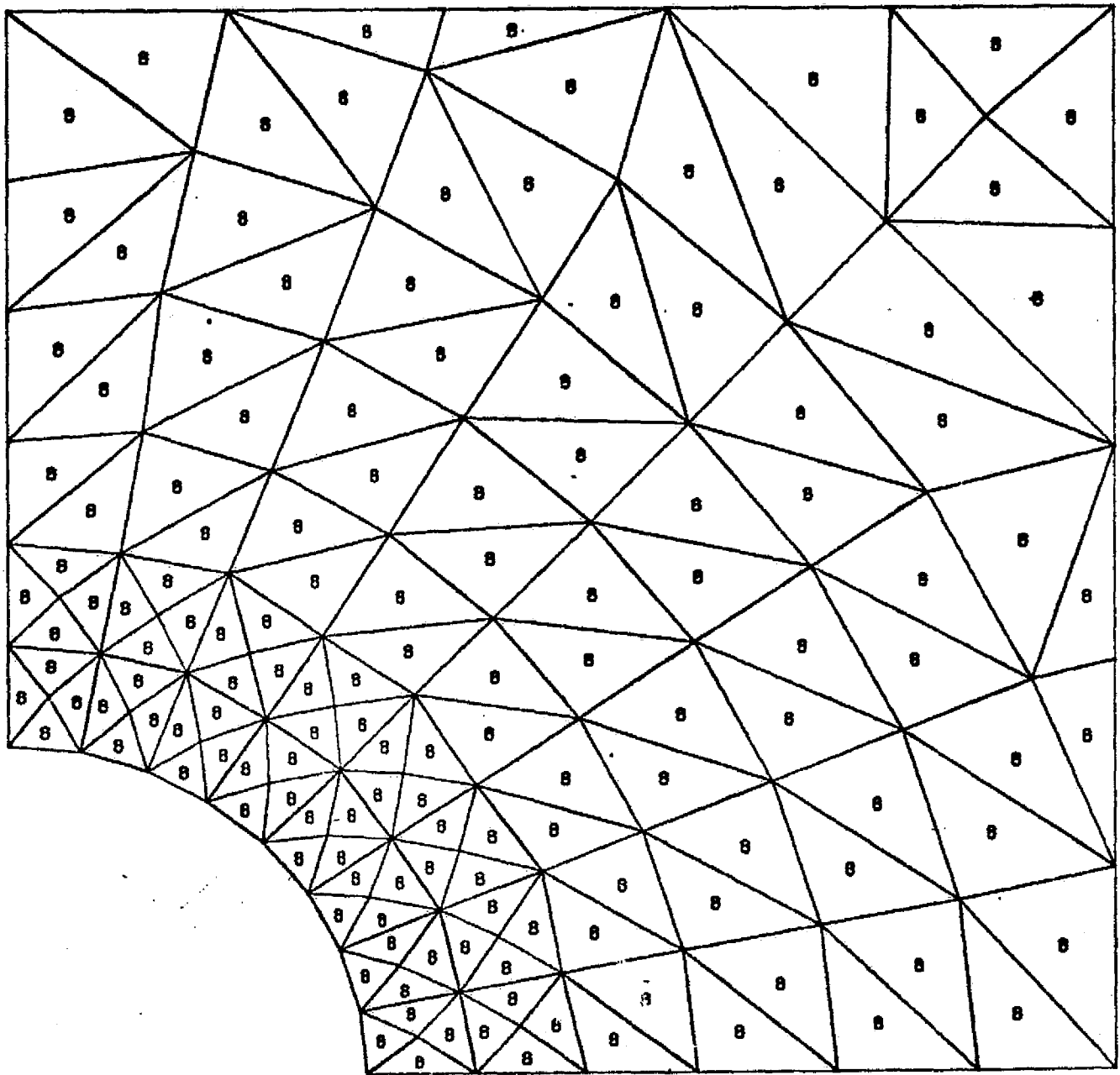
ELEMENT SECTION PROPERTY GROUPS

SPEC  
7'

NTE 9X12 DOOR REINF.  
OUTER RING

0 SCALE 15

Figure 15



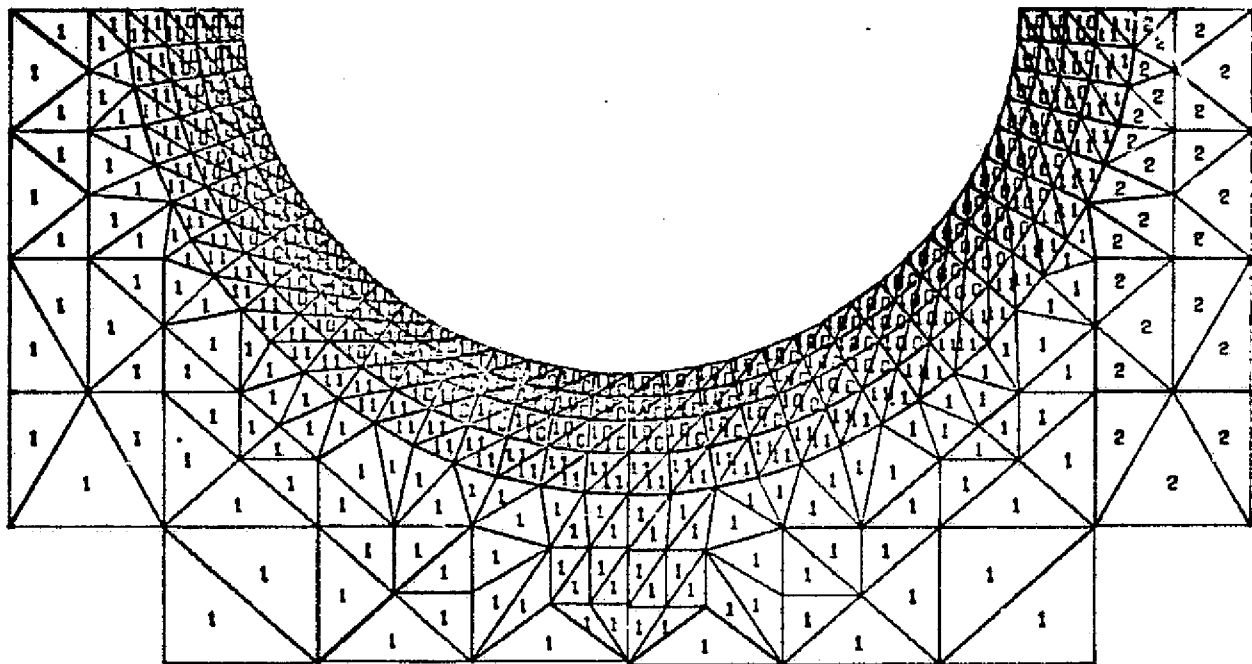
SPEC  
8.1

NTF 9 X 12 REINF  
CENTER TRIANGLES

0 SCALE

ELEMENT SECTION PROPERTY GROUPS

Figure 16



SPEC  
9.1

9 X 12 REINF WITH 9 FT HOLE  
TRIANGLES AROUND 9 FT HOLE

0 ——— 24  
SCALE

Figure 17

2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

SPEC  
10-1

9 X 12 REINE WITH 9 FT HOLE  
9 FT PIPE SECTION 1

0 SCALE 11

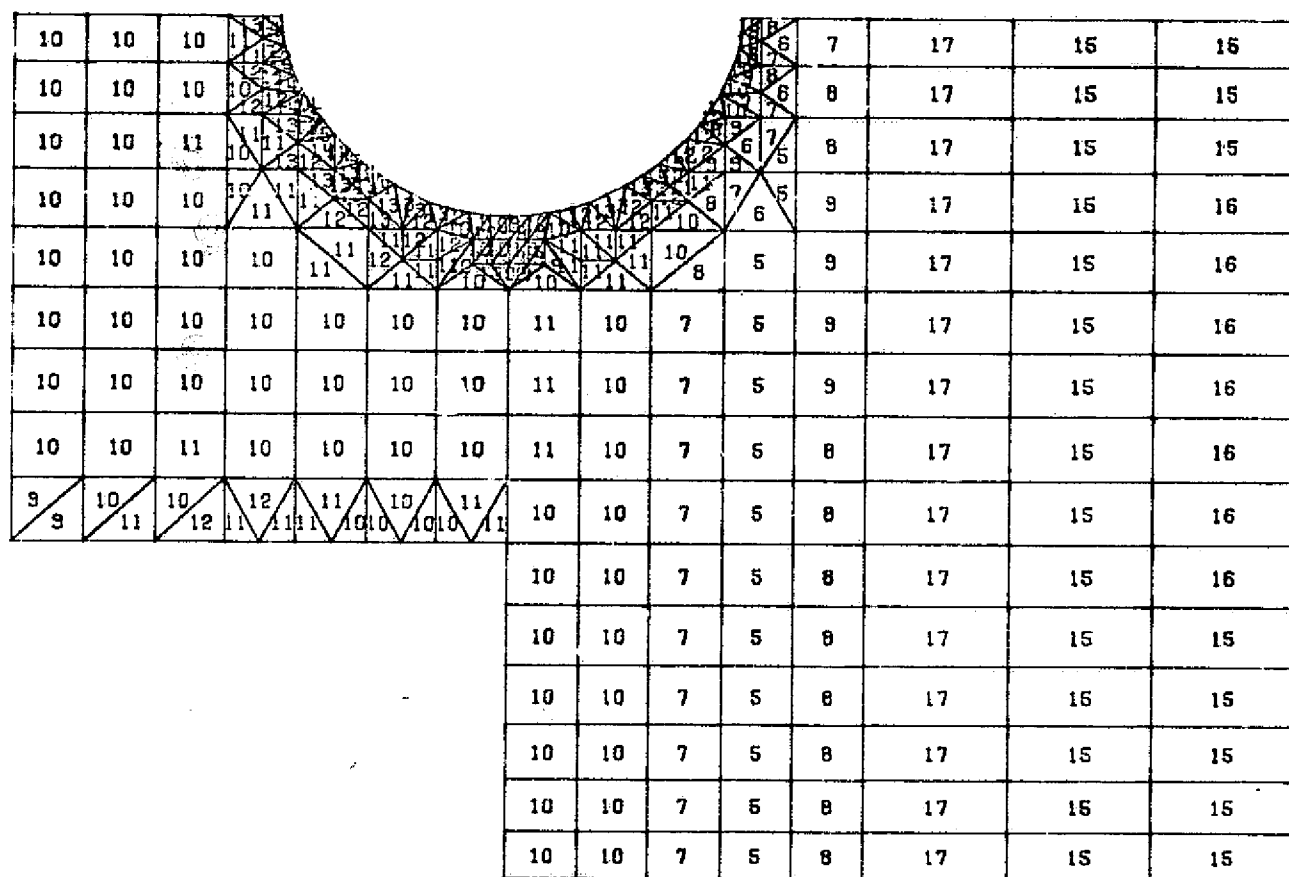
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Figure 18





10 / 1 / 1

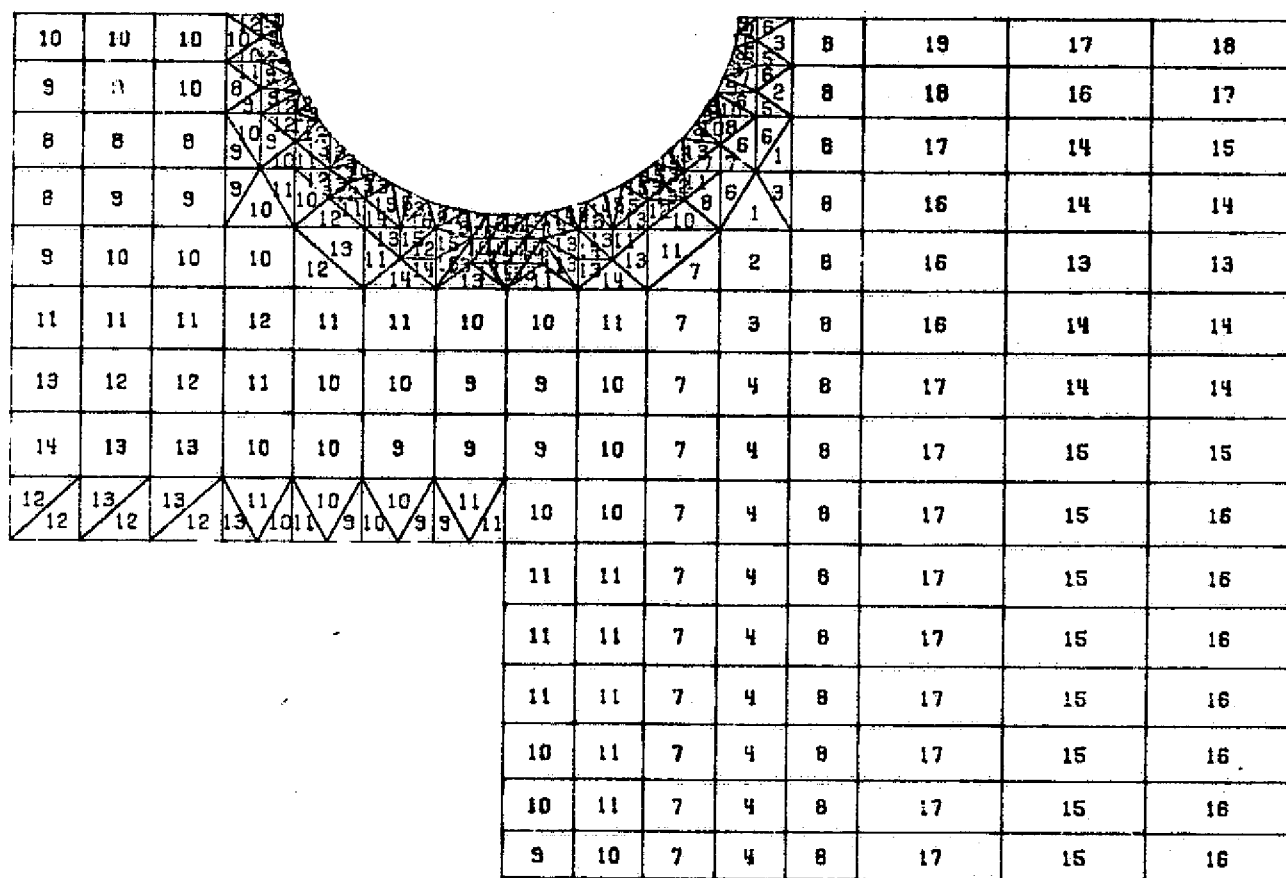


NTF 9 X 12 ACCESS OPENING  
SHELL

0 55  
SCALE

Figure 20

10 / 1 / 1

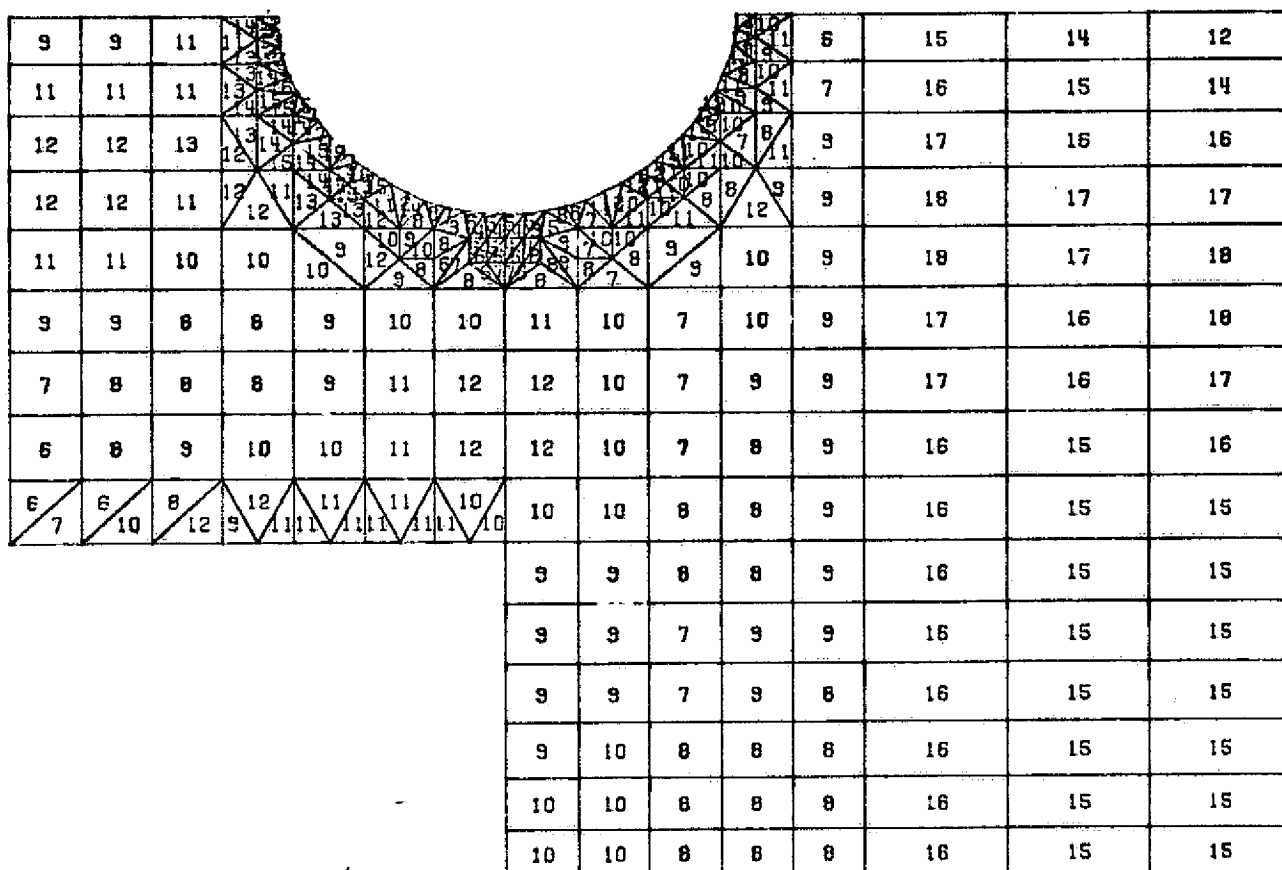


5.1 EC

NTF 9 X 12 ACCESS OPENING  
SHELL

Figure 21

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2



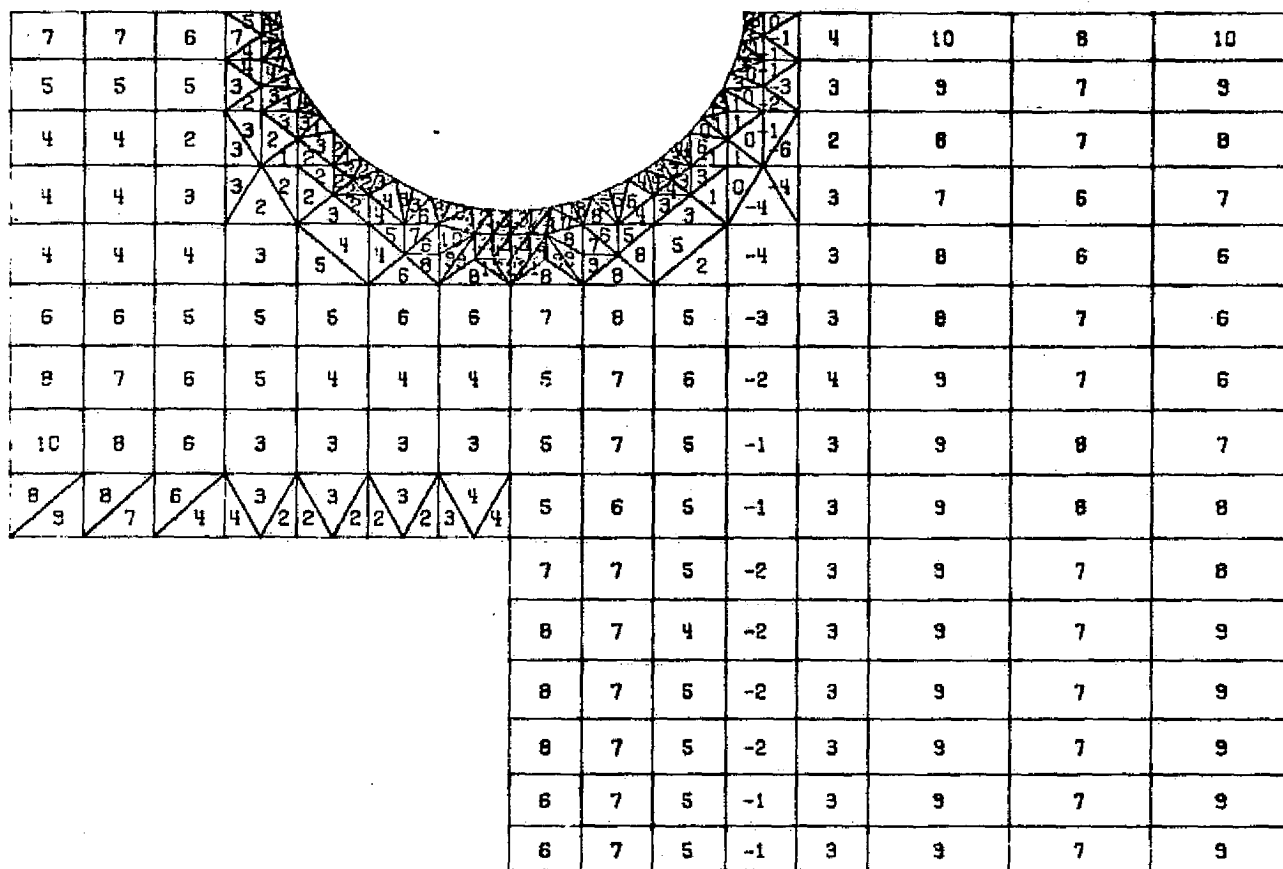
0 55  
SCALE

Figure 22



DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

10/1/1



SPEC  
3.1

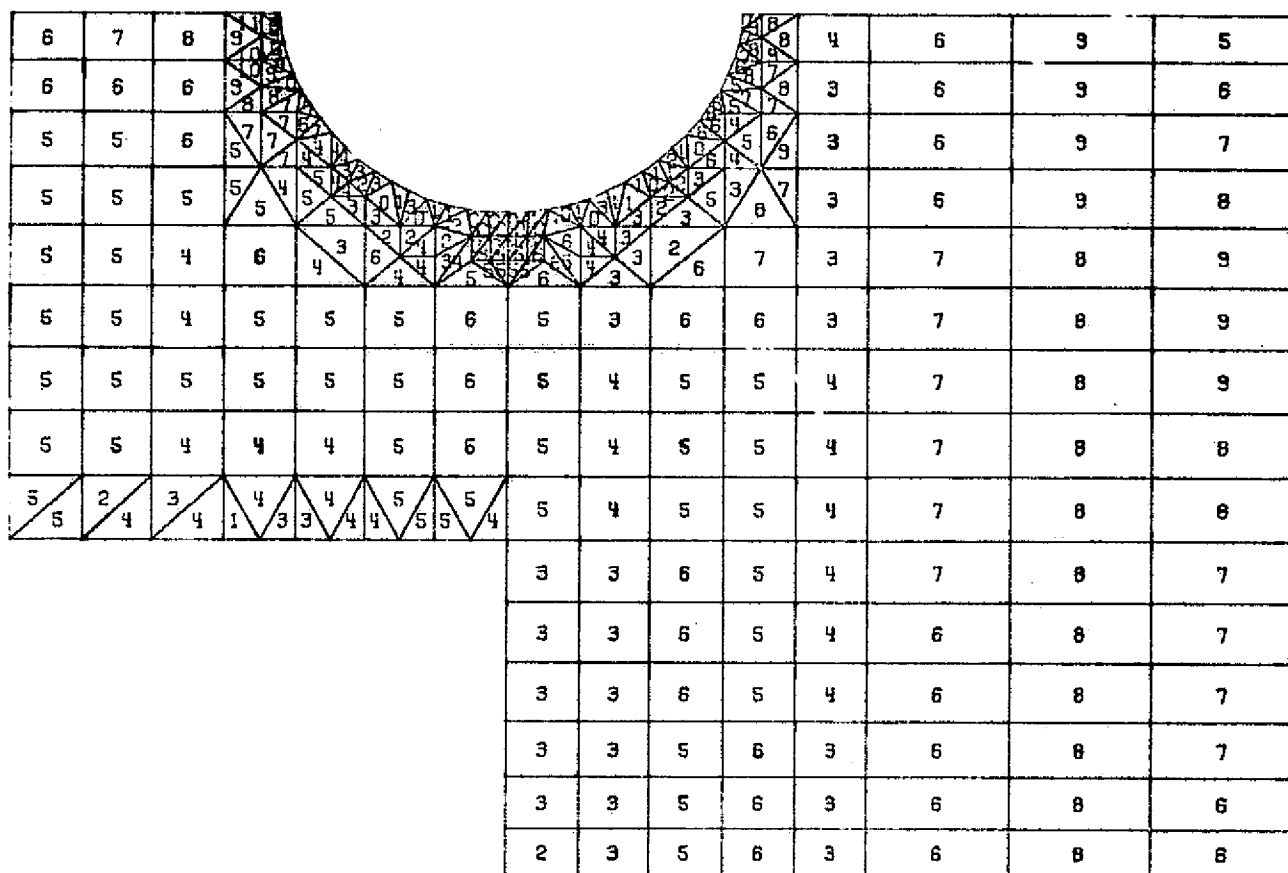
NTF 9 X 12 ACCESS OPENING  
SHELL

0 SCALE

Figure 24

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

10/1/1



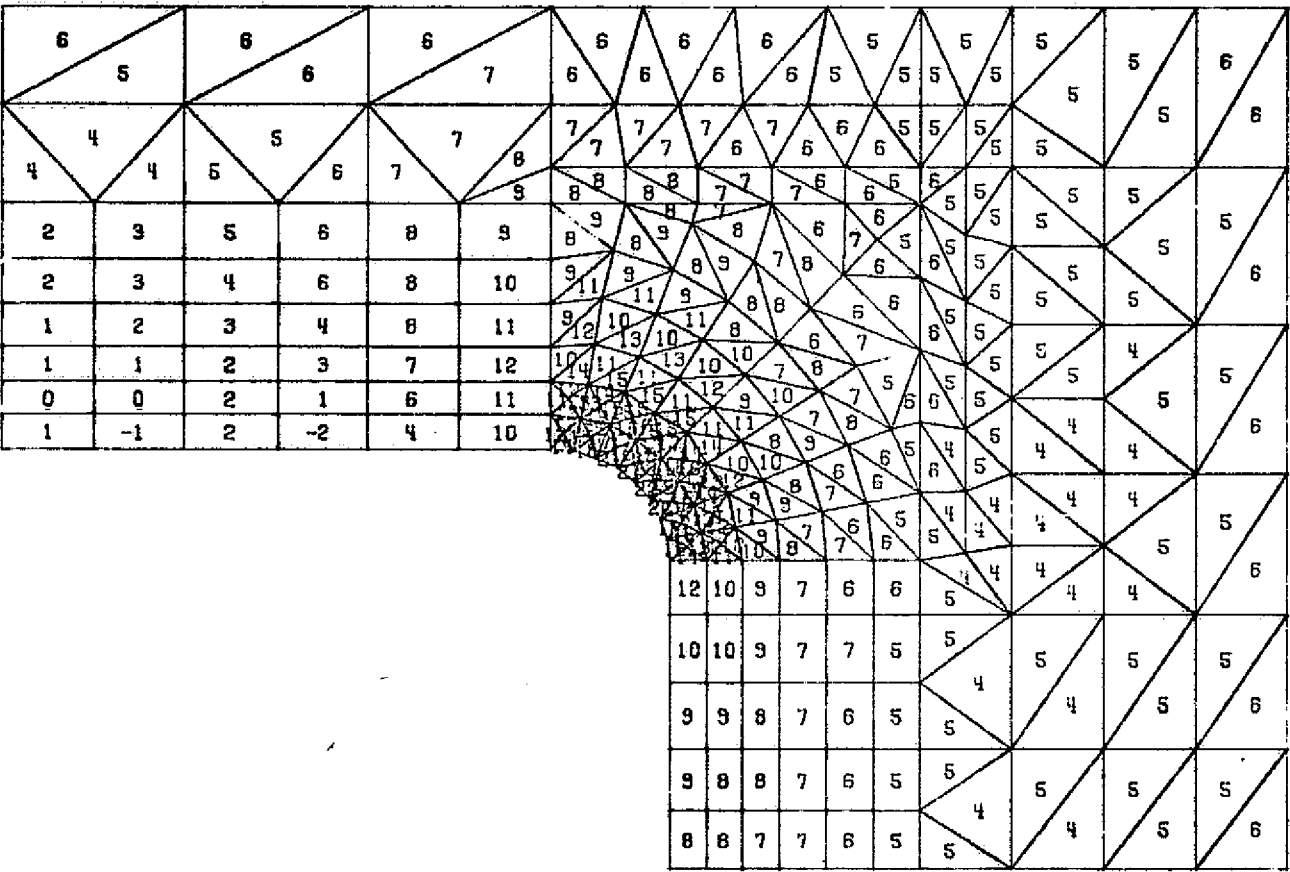
SPEC  
3.1

NTF 9 X 12 ACCESS OPENING  
SHELL

0 SCALE 55

Figure 25

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0 10/1/1



REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
4.1

NTF 9 X 12 ACCESS OPENING  
SHELL

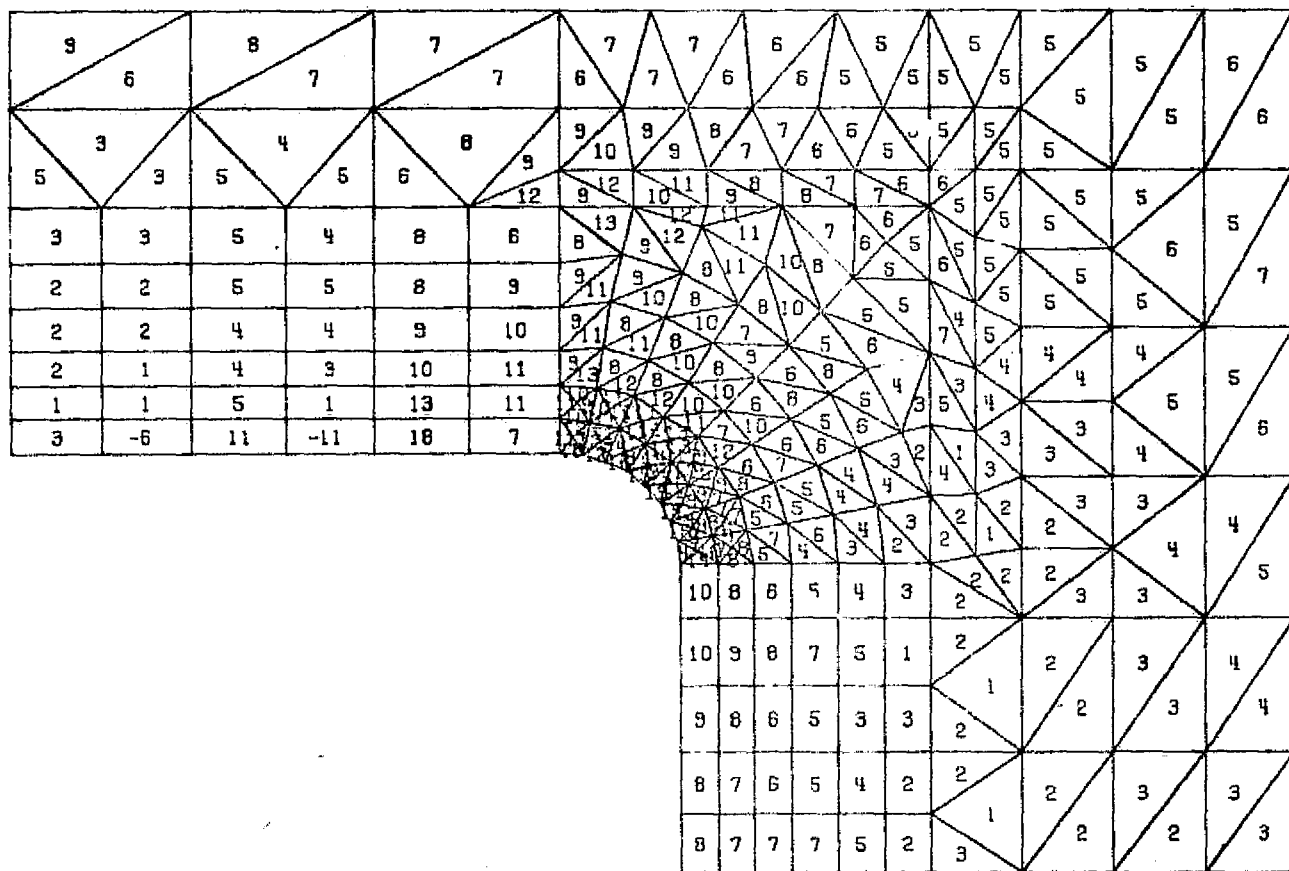
0 21  
SCALE

Figure 26



DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1



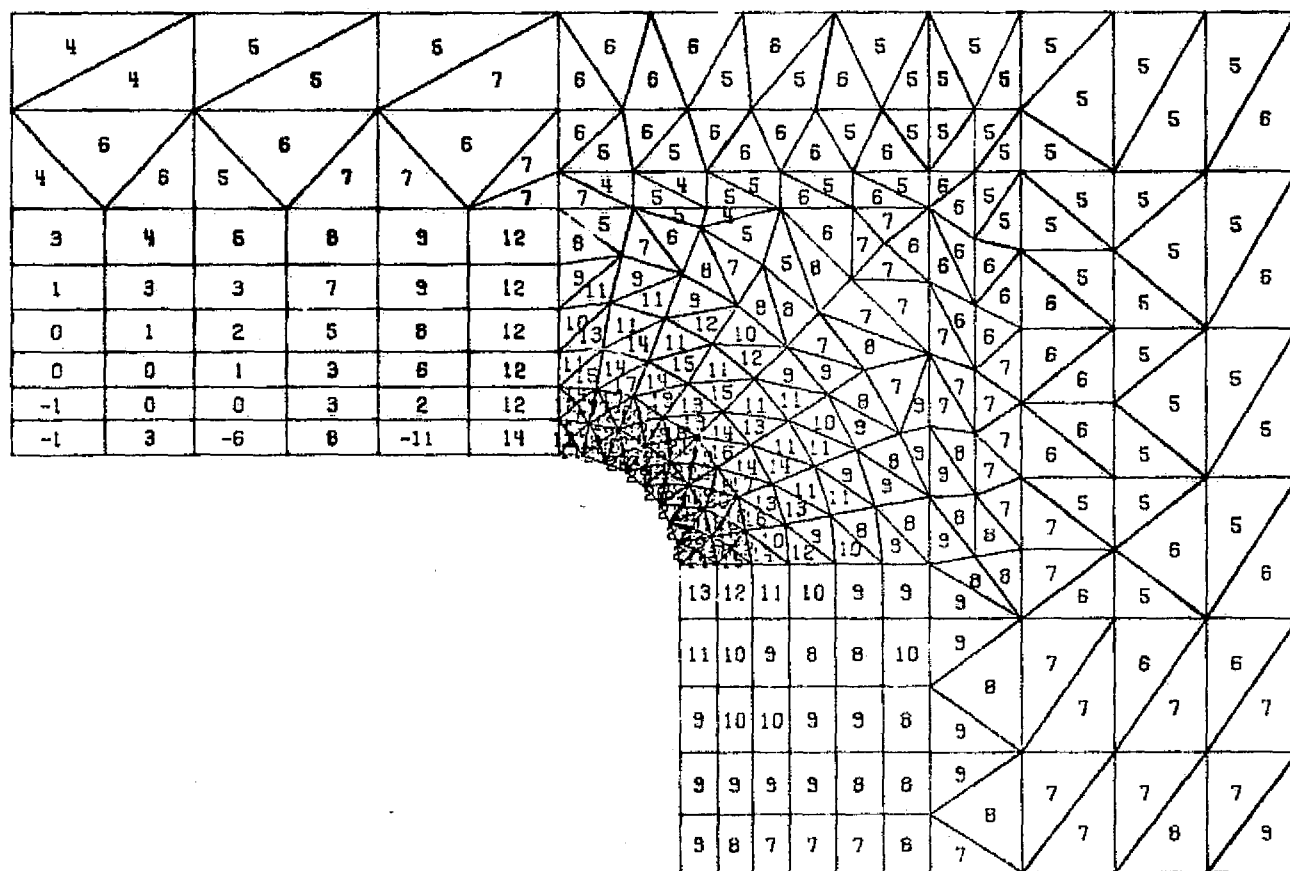
SPEC  
4.1

NTF 9 X 12 ACCESS OPENING  
SHELL

0 SCALE 21

Figure 27

10 / 1 / 1

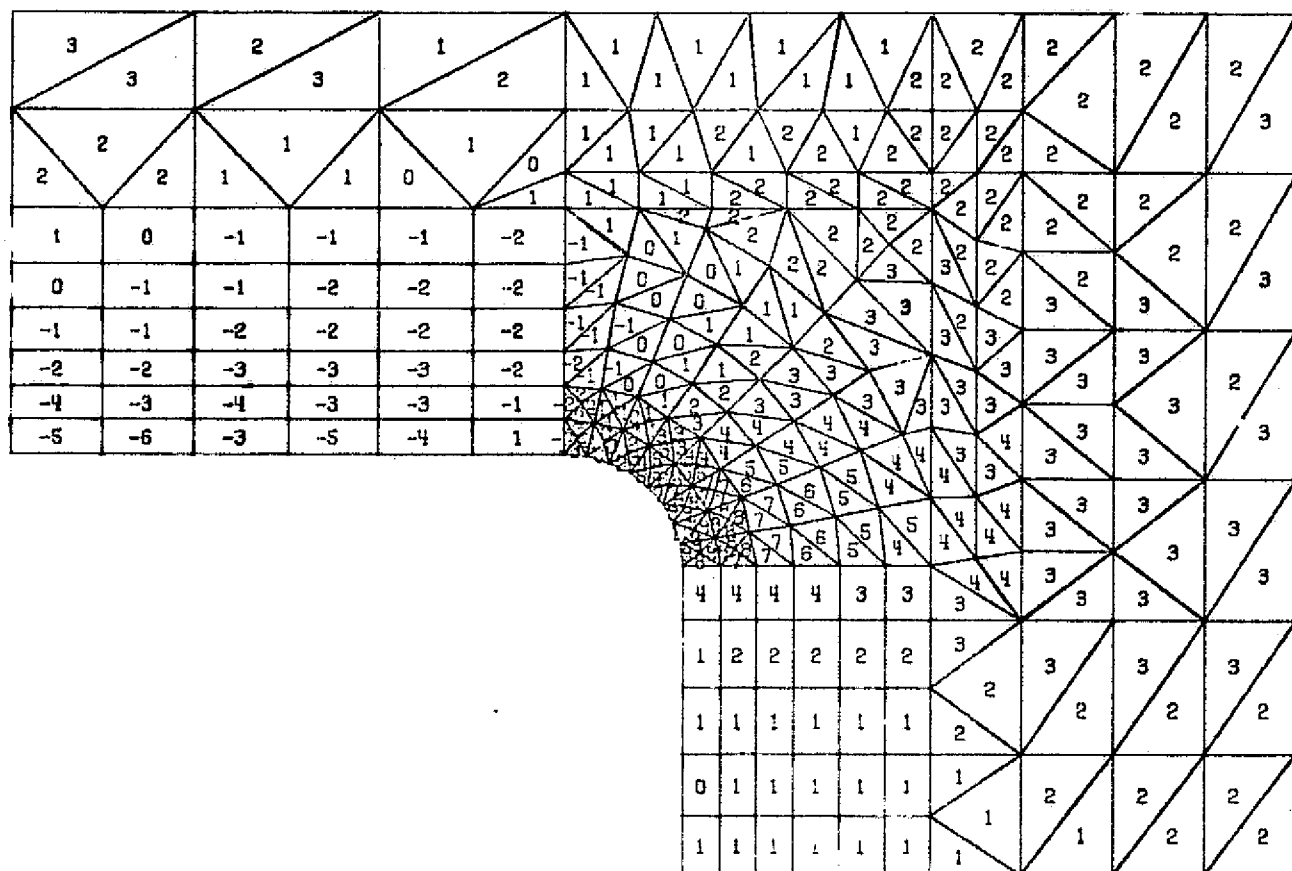


SPEC NTF 9 X 12 ACCESS OPENING  
4.1 SHELL

Figure 28

DISPLAY= PS2 /100C , NODE= 1, SURFACE= 0

10/1/



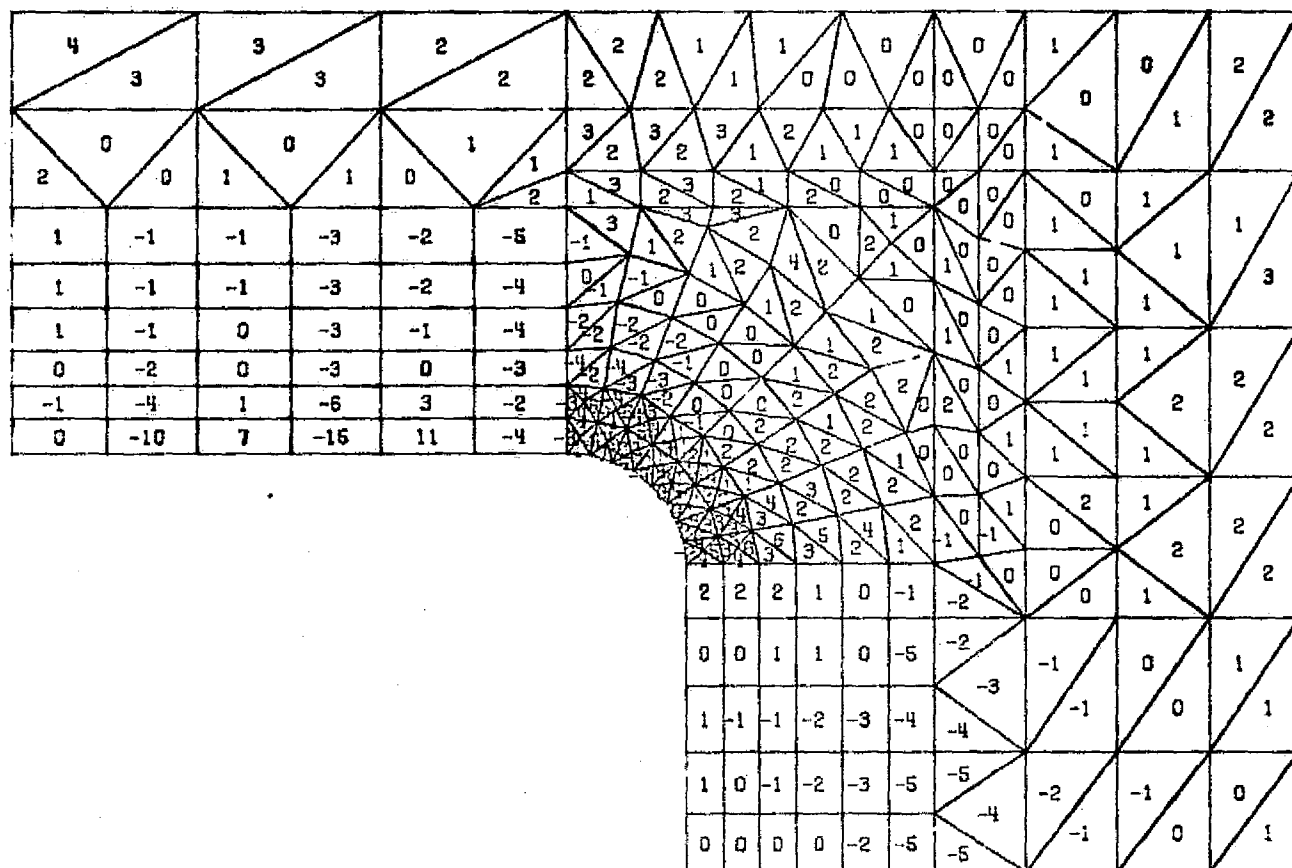
SPEC  
4.1

NTF 9 X 12 ACCESS OPENING  
SHELL

0 SCALE

Figure 29

10 / 1 / 1

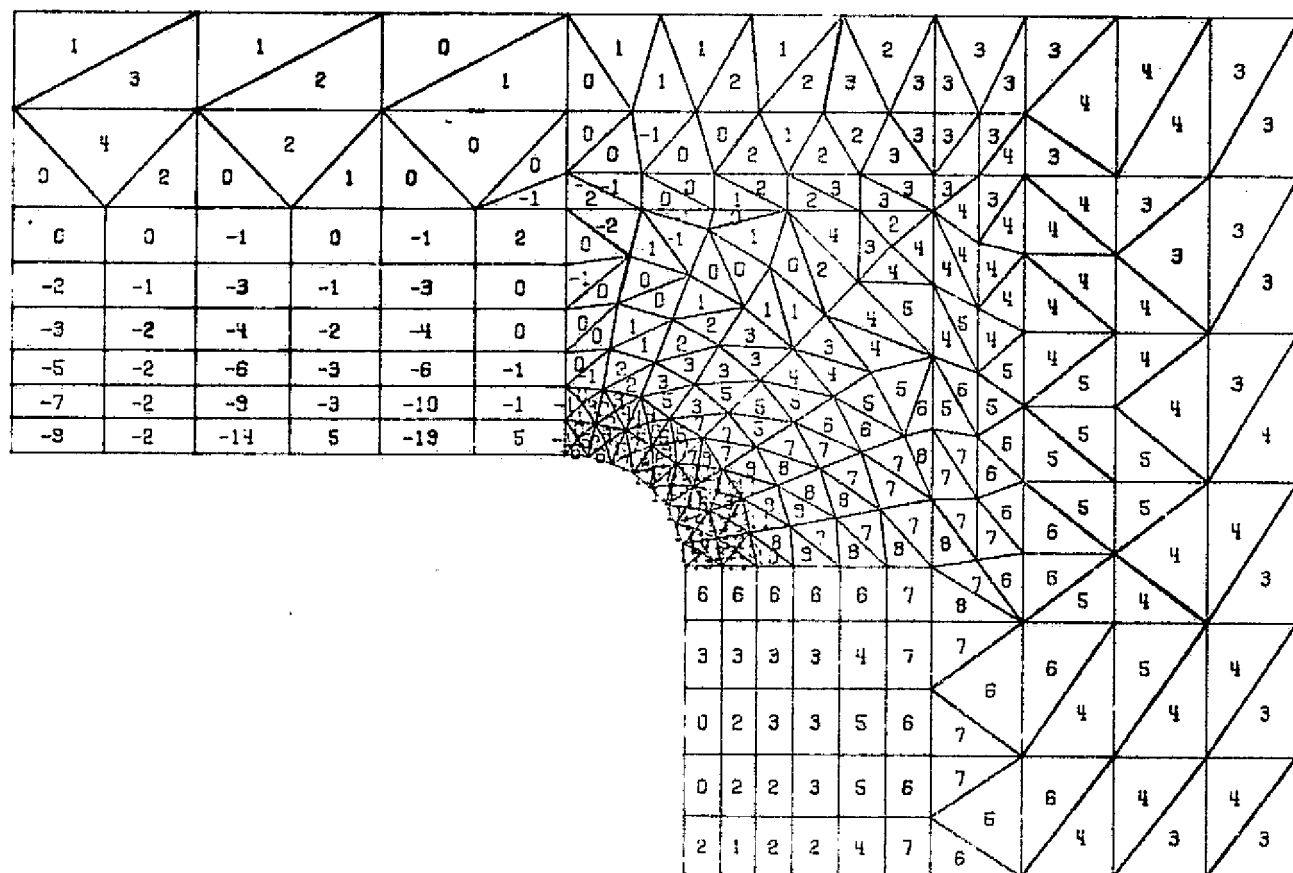


0 \_\_\_\_\_ 2  
SCALE

Figure 30

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

10/1/1



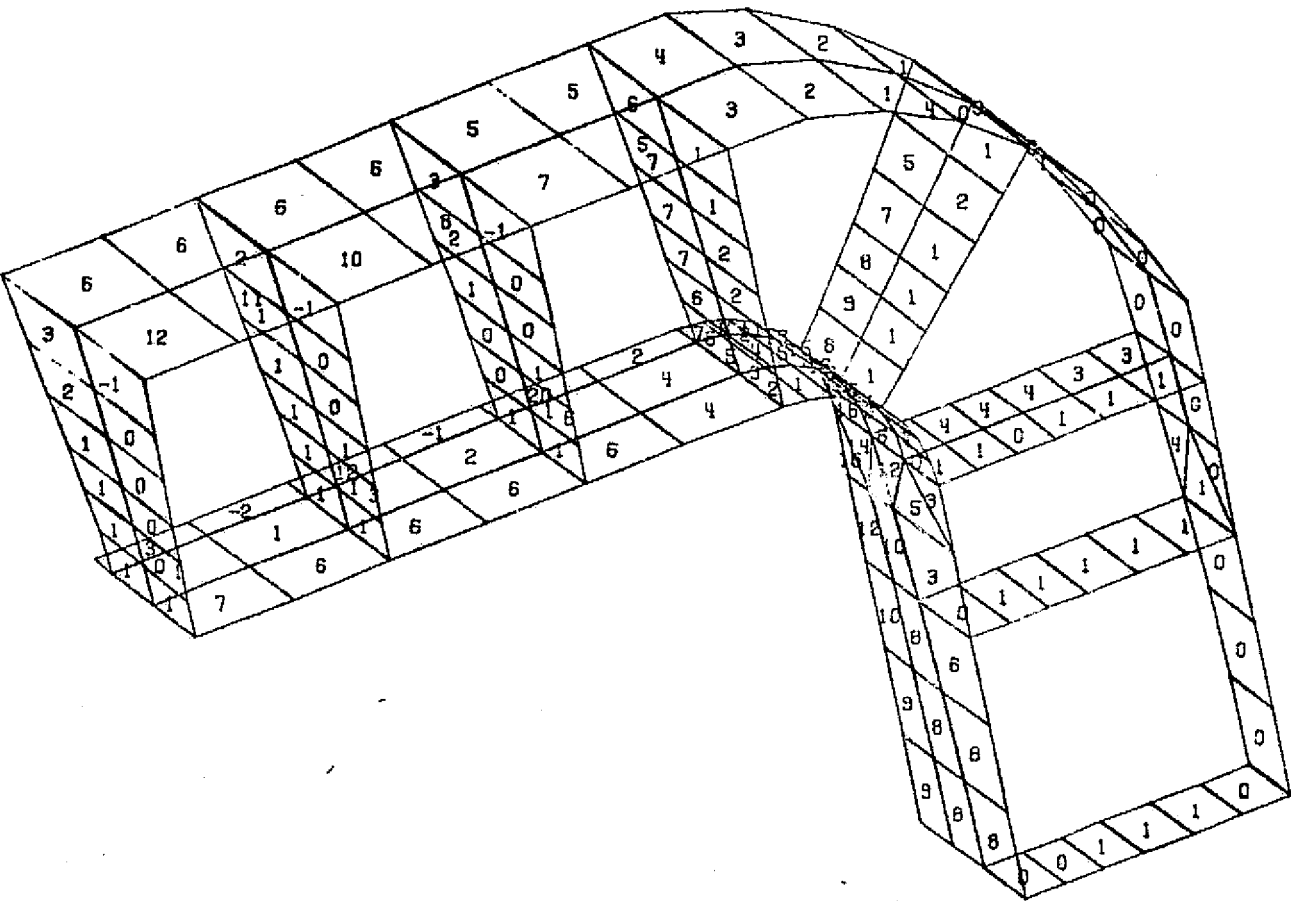
SPEC  
4.1

NTF 9 X 12 ACCESS OPENING  
SHELL

0 SCALE 2

Figure 31

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0 10/1/1

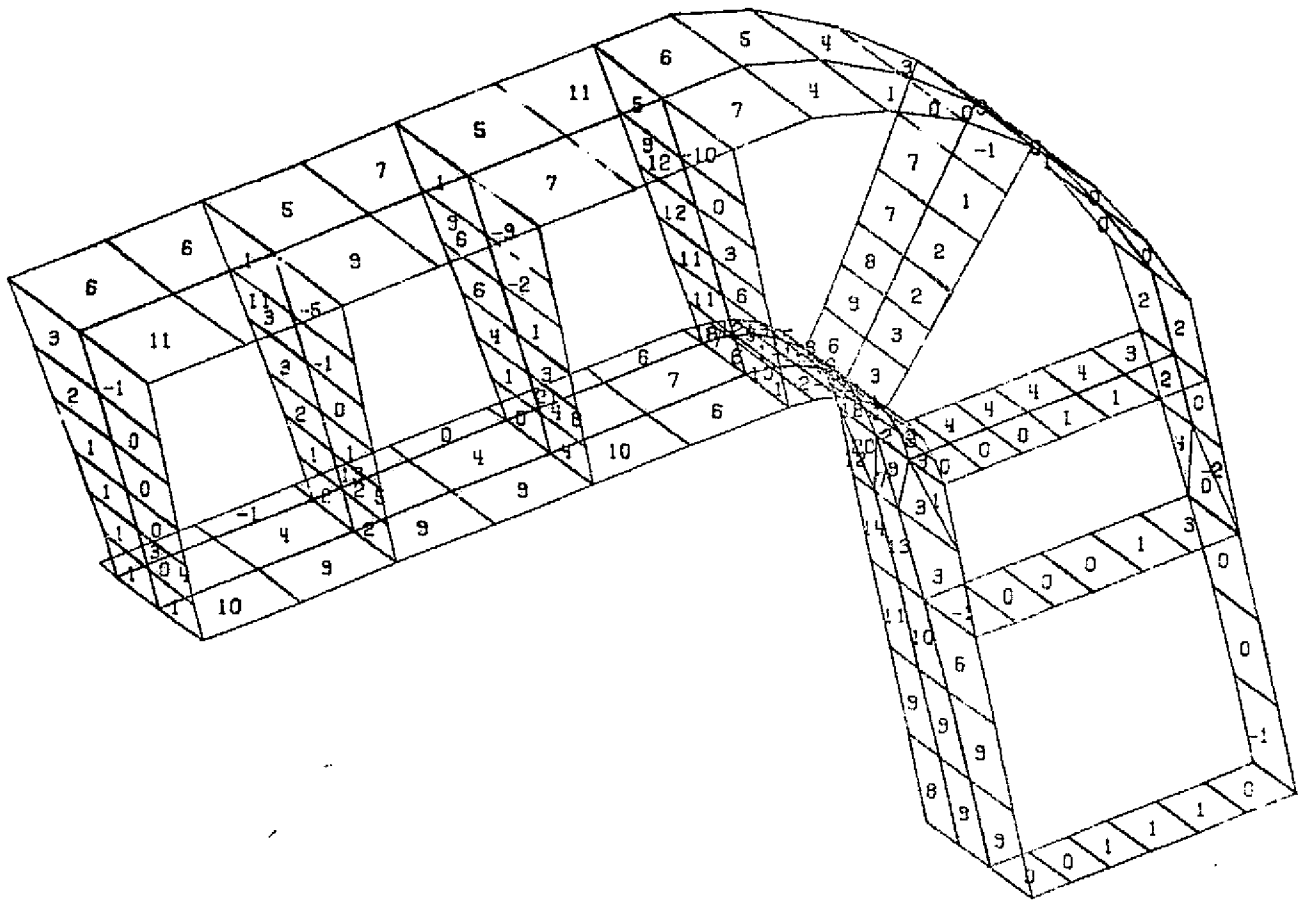


SPEC 5.1 NTF 9X12 ACESS OPENING GUSSET 0 SCALE 18

Figure 32

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 1



SPEC  
5.1

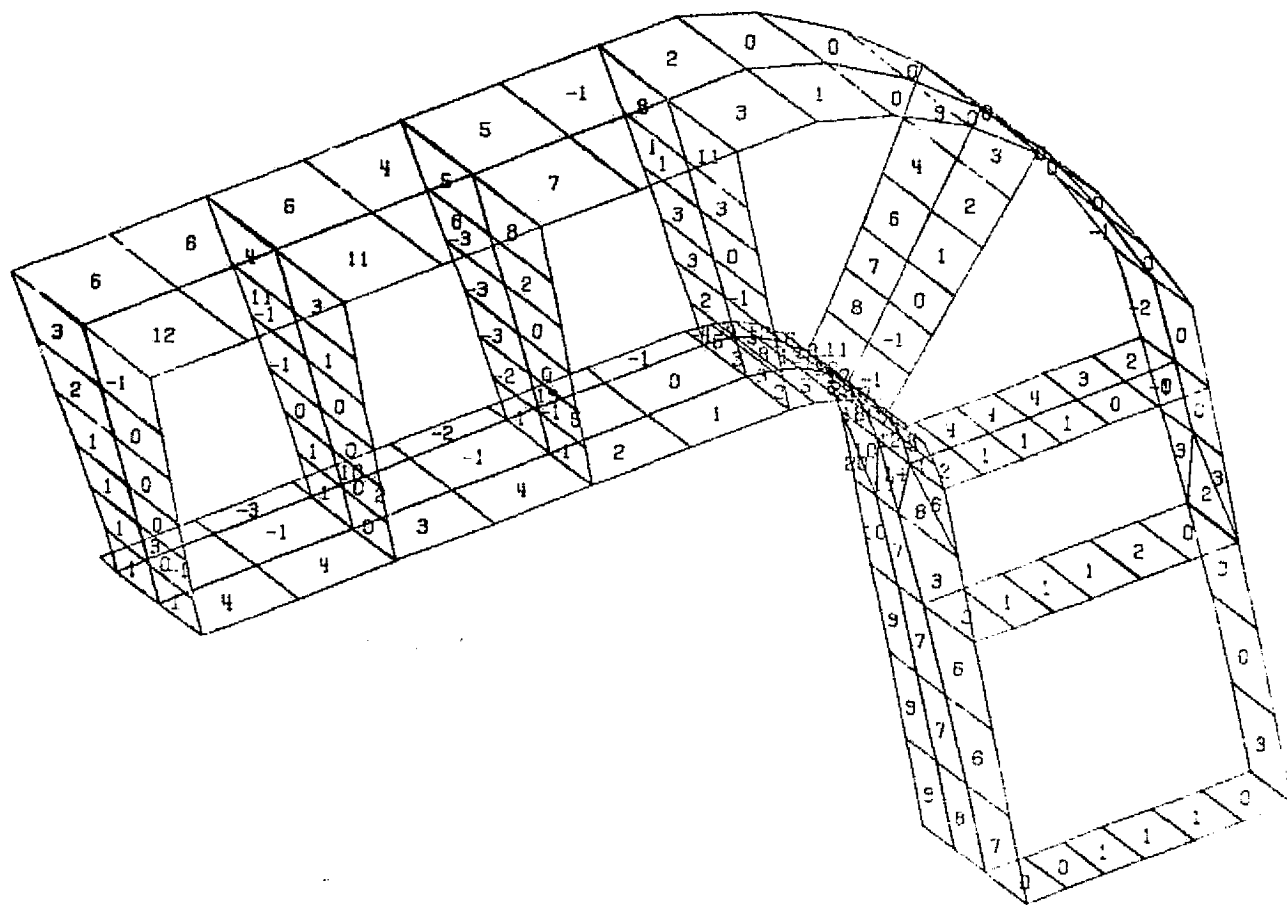
NTF 9X12 ACCESS OPENING  
GUSSET

0 SCALE 18

Figure 33

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

10/1/1



SPEC  
5.1

NTF 9X12 ACCESS OPENING  
GUSSET

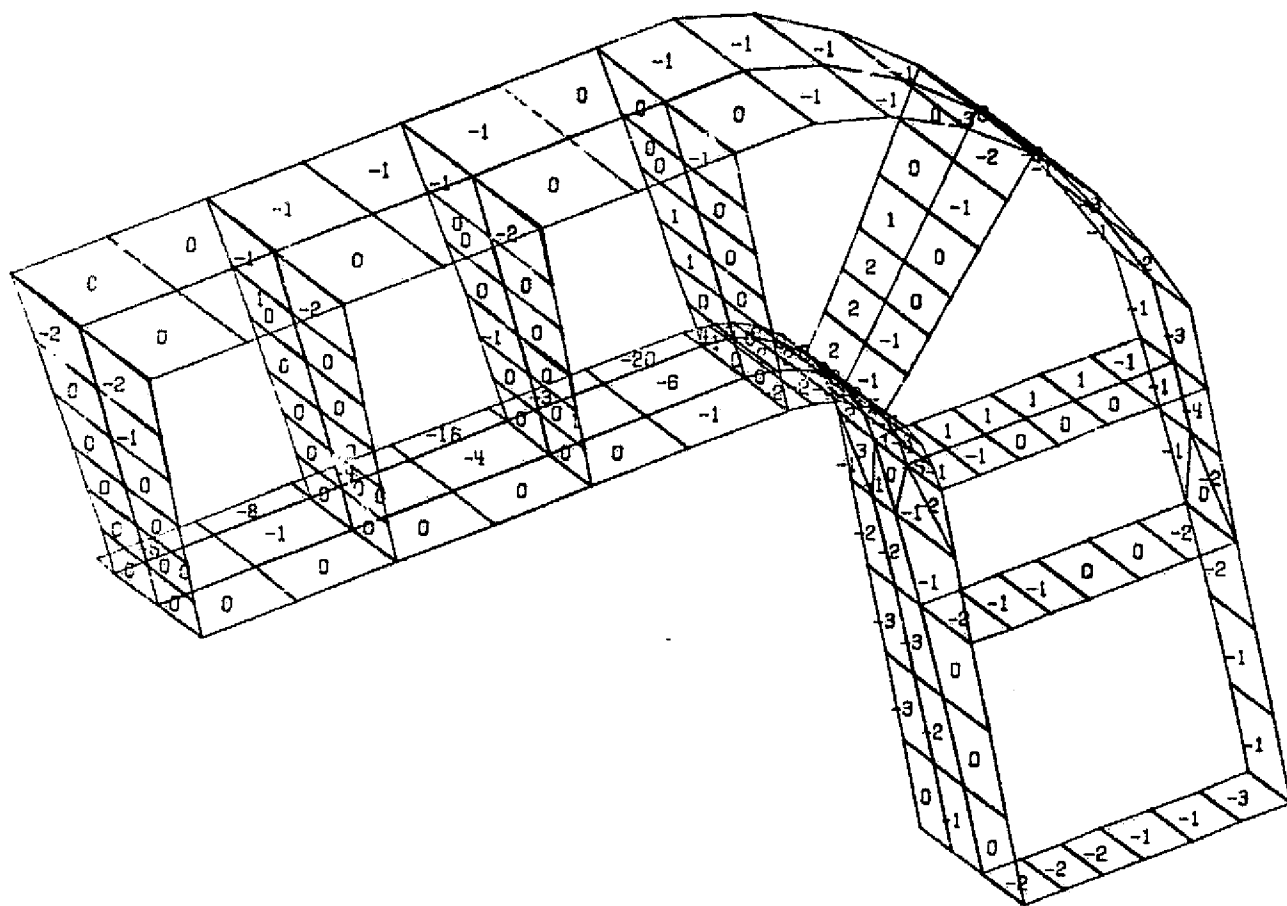
0 16  
SCALE

Figure 34



DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0

10/1/



SPEC  
5.1

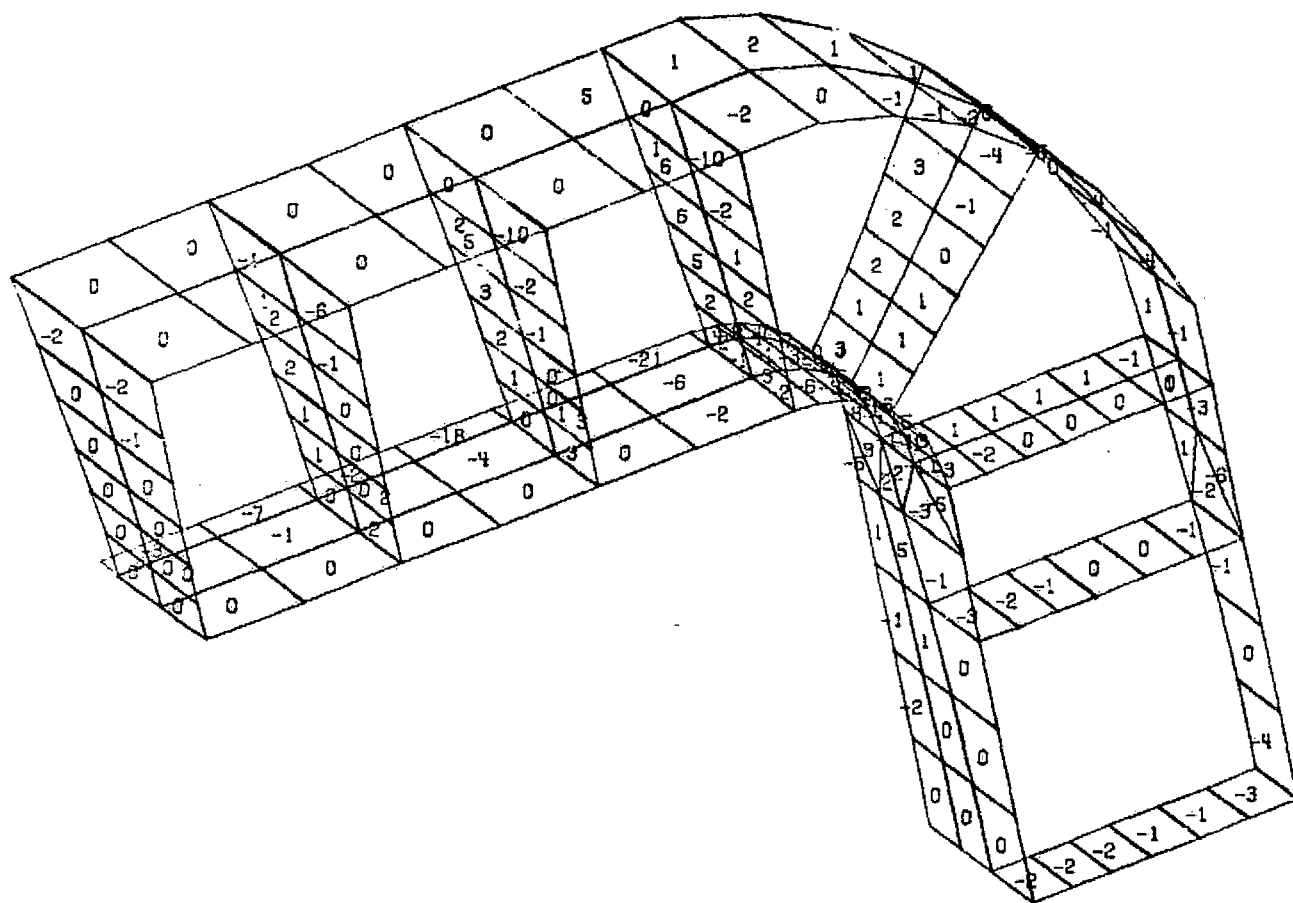
NTF 9X12 ACCESS OPENING  
GUSSET

0 SCALE

Figure 35

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

10/1/1



SPEC  
5.1

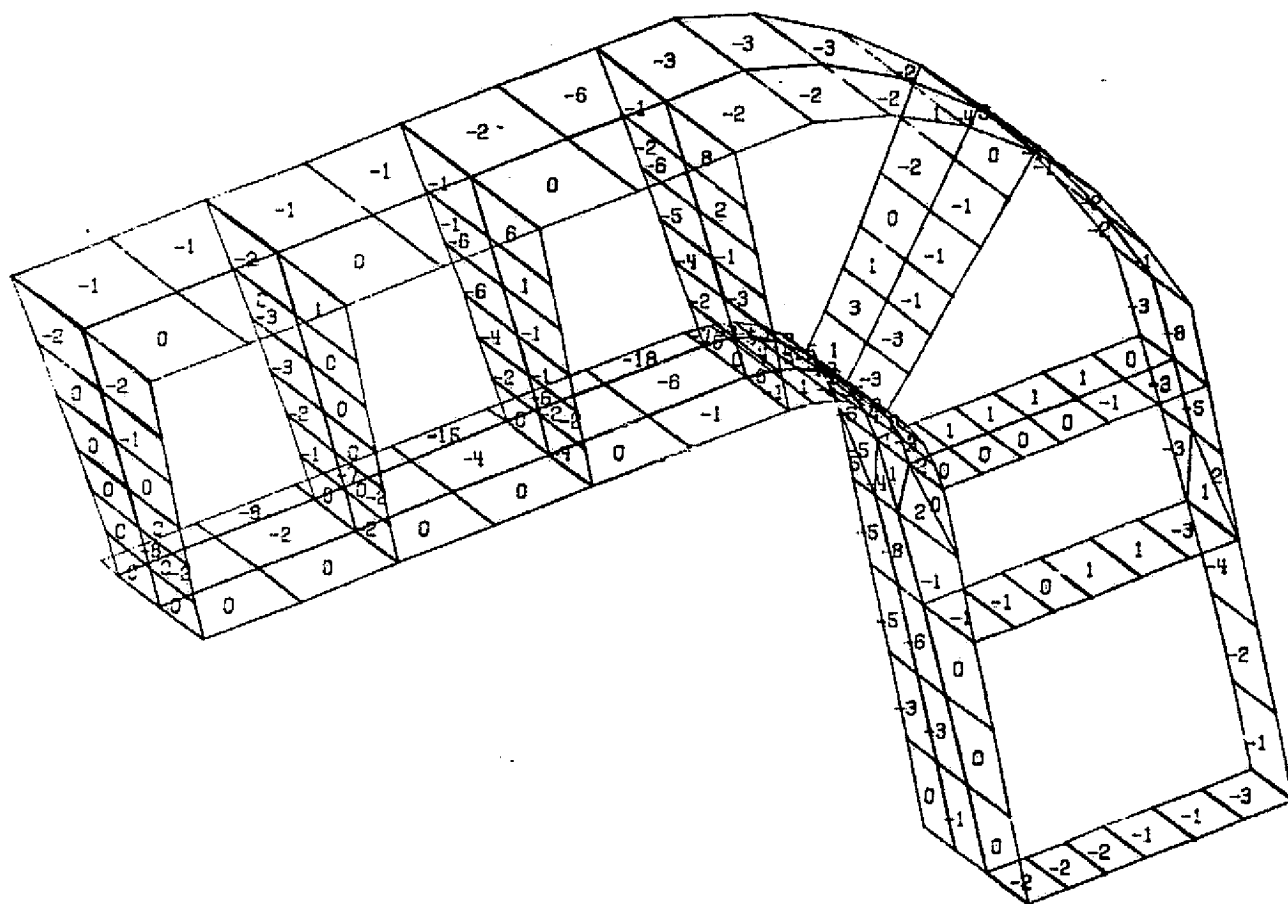
NTF 9X12 ACCESS OPENING  
GUSSET

0 SCALE

Figure 36

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

10/1/1



SPEC  
5.1

NTF 9X12 ACCESS OPENING  
GUSSET

0 18  
SCALE

Figure 37

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0

10/1/1

9	8	8
9	8	8
10	8	6
12	10	3
16	12	5
14	12	3
16	6	0
16	6	1
16	6	1
15	6	1
13	5	1
11	5	1
8	4	1
7	5	2
2	4	4
20	6	6
-1	2	8
12	3	8
-2	1	6
3	1	7

SPEC  
6.1

NTE 9X12 REINF.  
INNER RING

0 SCALE 14

Figure 38

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 1

10/1/1

8	9	9
9	9	9
11	10	6
14	13	3
12	7	3
20	9	1
18	2	3
15	0	2
16	-1	1
18	-2	1
15	-2	0
13	-1	-1
12	1	-2
10	6	1
6	7	6
21	8	10
0	4	9
13	5	9
-1	4	9
3	4	10

SPEC 6.1 - NTF 9X12 REINF.  
INNER RING

0 SCALE 14

Figure 39

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2 10/1/

9	8	7
9	7	6
9	7	6
10	7	3
20	17	8
10	14	6
18	12	1
22	15	3
22	17	4
18	17	7
16	15	6
12	12	6
4	8	5
-4	3	2
-1	0	1
19	5	2
-2	-1	4
10	2	3
-3	-1	4
3	-1	4

SPEC NTF 9X12 REINF.  
6.1 INNER RING

0 SCALE

Figure 40

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

10/1/1

0	-1	0
-3	-2	0
-3	-3	0
-2	-2	-1
-1	-1	-1
3	0	-2
2	1	-5
0	2	-5
0	2	-5
0	2	-5
0	2	-4
0	2	-3
0	2	-2
4	0	-2
-20	-6	-1
-3	1	0
-16	-4	0
-4	0	0
-8	-1	0
-5	0	0

SPEC  
6.1

NTF 9X12 REINF.  
INNER RING

0 SCALE 14

Figure 41

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1

10/1/1

0	0	0
-2	0	0
-1	1	0
1	5	-1
-6	2	-3
9	-2	-5
8	-1	-11
6	-4	-13
7	-6	-15
10	-8	-16
7	-5	-13
7	-3	-9
9	-1	-6
14	-1	-2
-21	-6	-2
0	3	0
-18	-4	0
-2	2	0
-7	-1	0
-3	0	0

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
6.1

NTF 9X12 REINF.  
INNER RING

0 SCALE 15

Figure 42



DISPLAY= PS2 /100C , NODE= 1 , SURFACE= 2

10/1/1

0	-1	0
-3	-3	0
-5	-6	0
-5	-8	-1
5	-4	2
-5	1	0
-6	1	-2
-10	4	-1
-12	5	0
-15	6	0
-12	5	1
-10	5	1
-9	4	1
-7	0	-1
-18	-6	-1
-6	-2	0
-15	-4	0
-7	-2	0
-8	-2	0
-8	-2	0

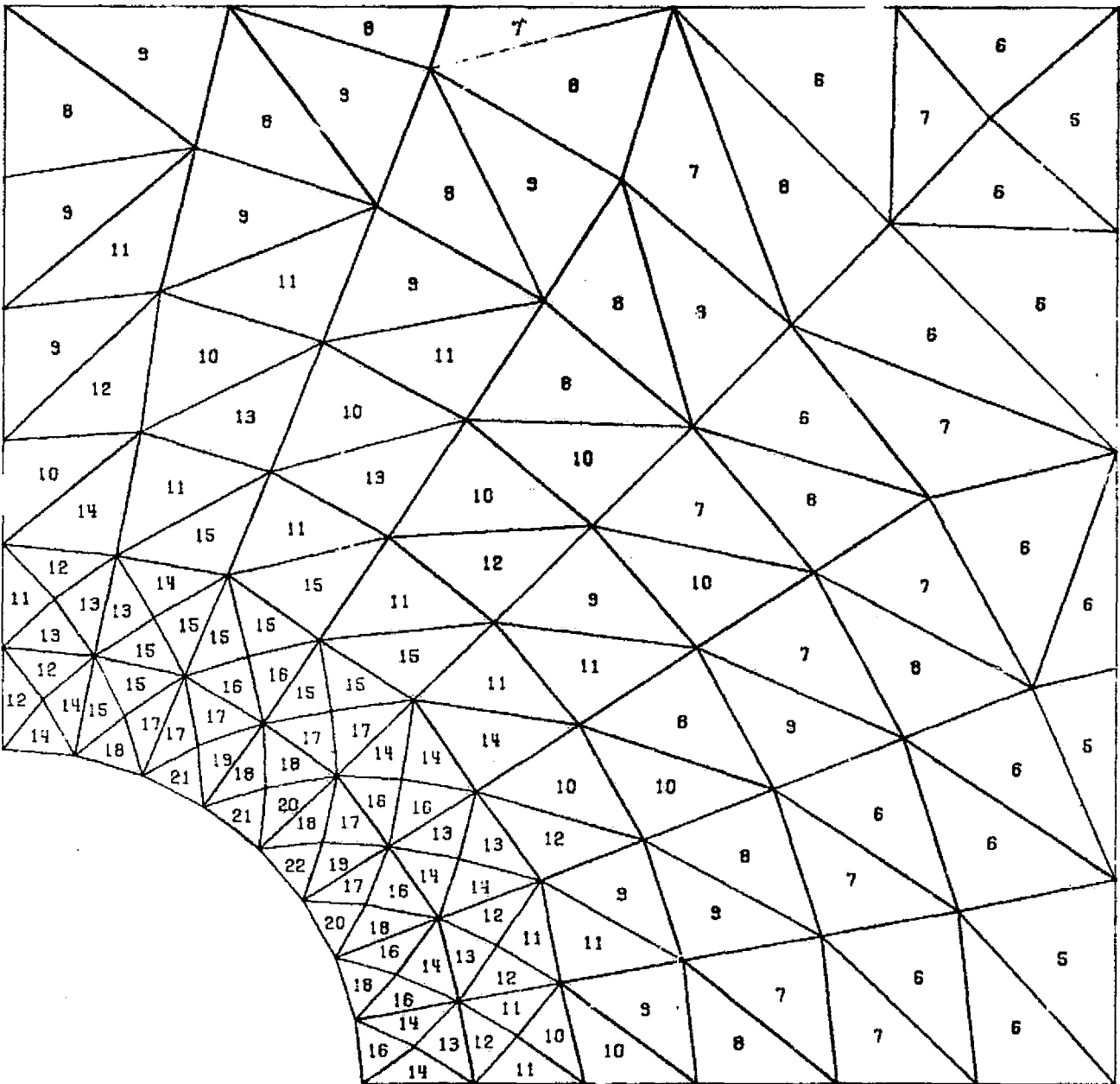
SPEC  
6.1

NTF 9X12 REINF.  
INNER RING

0 SCALE 10

Figure 43

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0 10/1/1

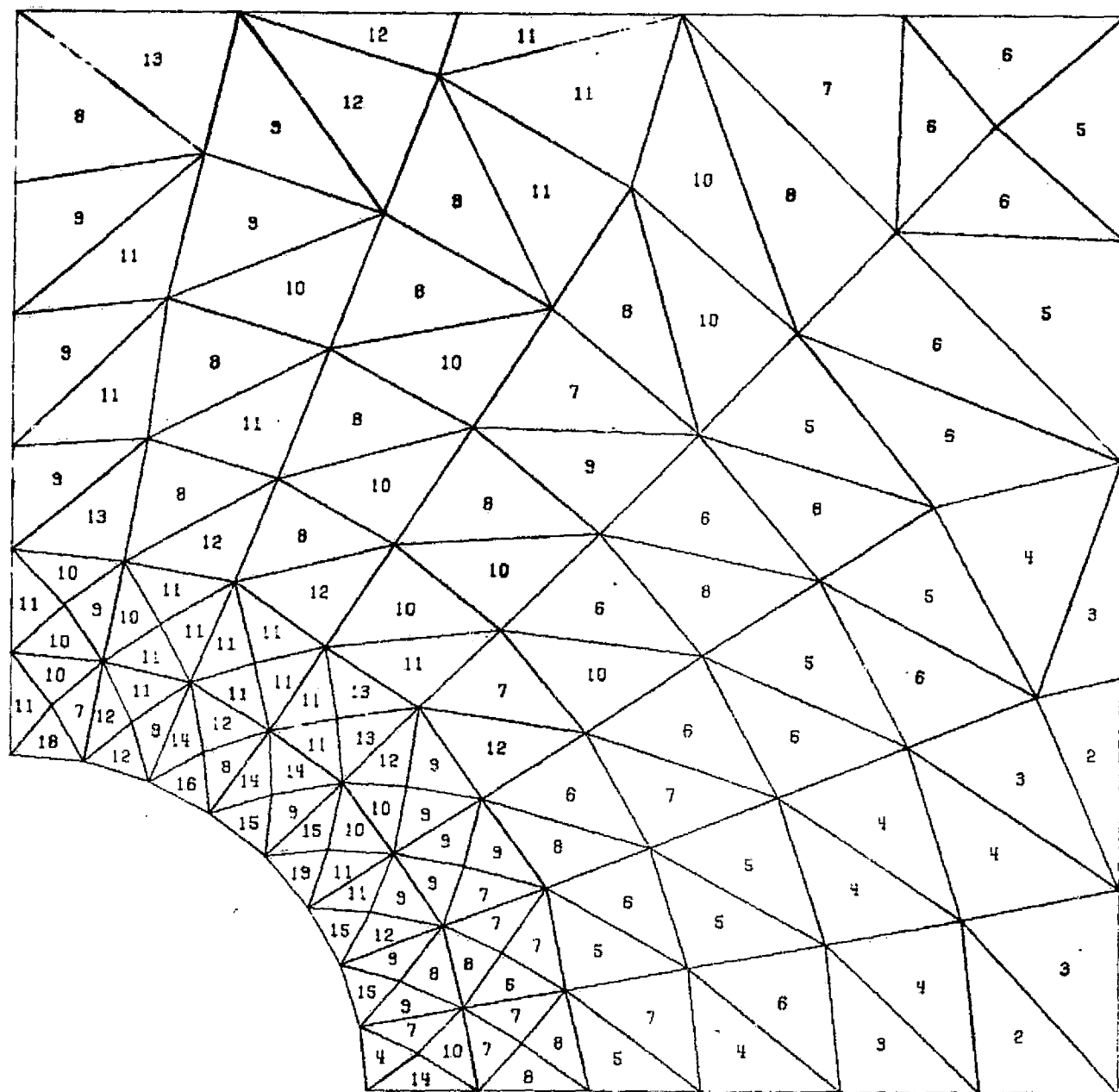


SPEC 3.1 NTF 9 X 12 REINF CENTER TRIANGLES 0 SCALE 6

Figure 44

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 1

10/1/1



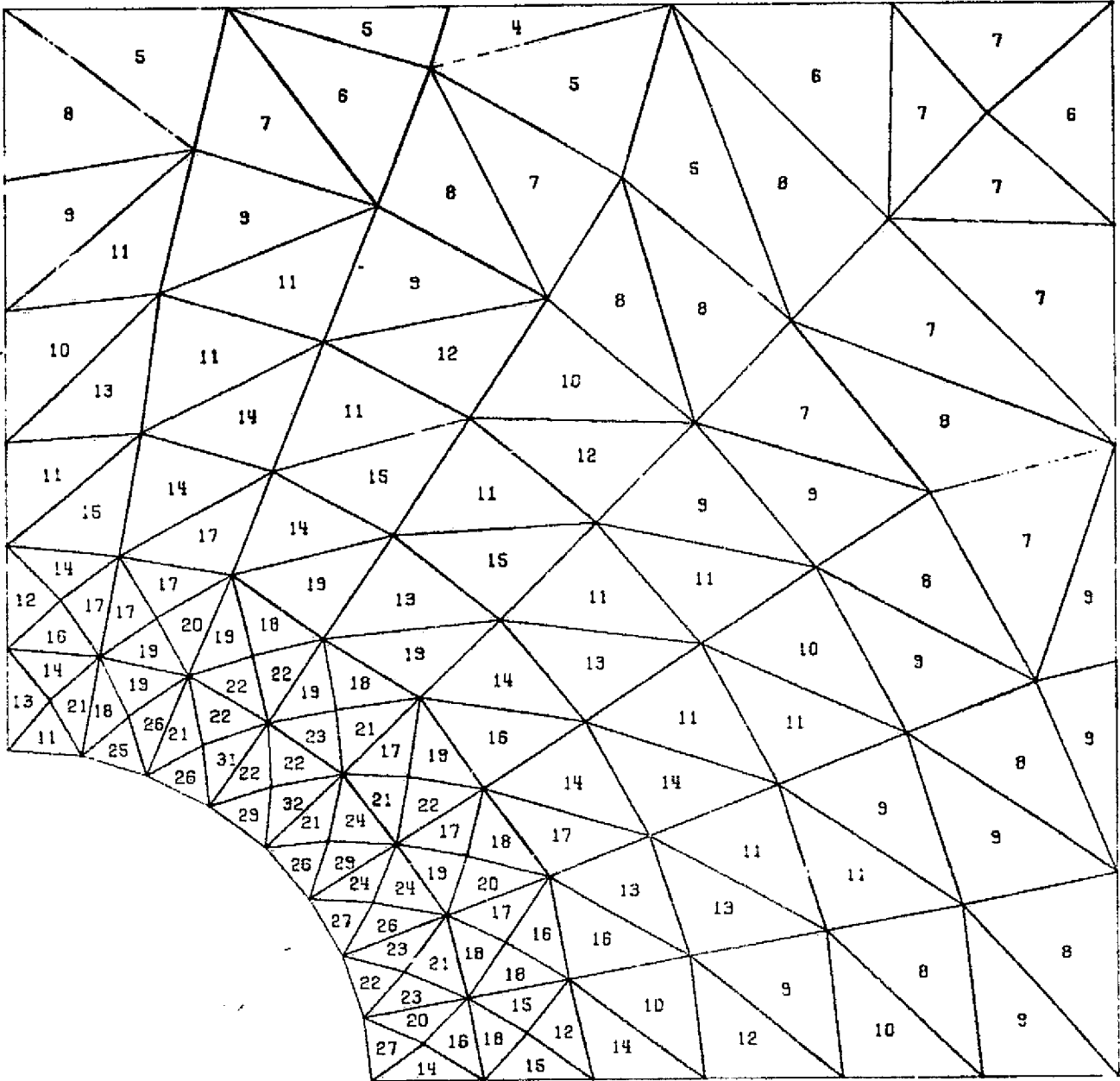
SPEC  
8.1

NTF 9 X 12 REINF  
CENTER TRIANGLES

Q SCALE 6

Figure 45

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2 10/1/1

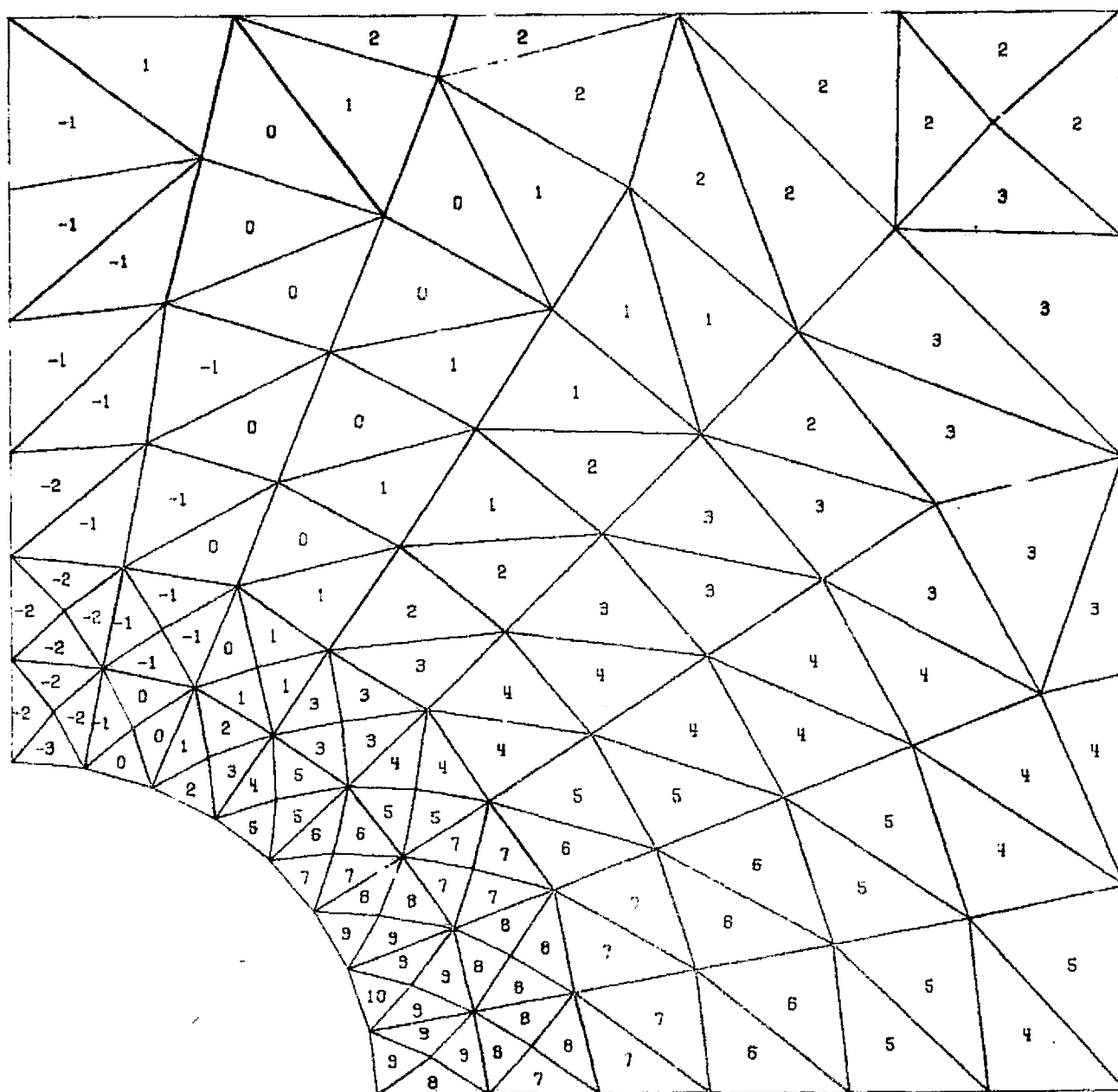


SPEC 8.1 NTE 9 X 12 REINF CENTER TRIANGLES 0 SCALE

Figure 46

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0



SPEC  
8.1

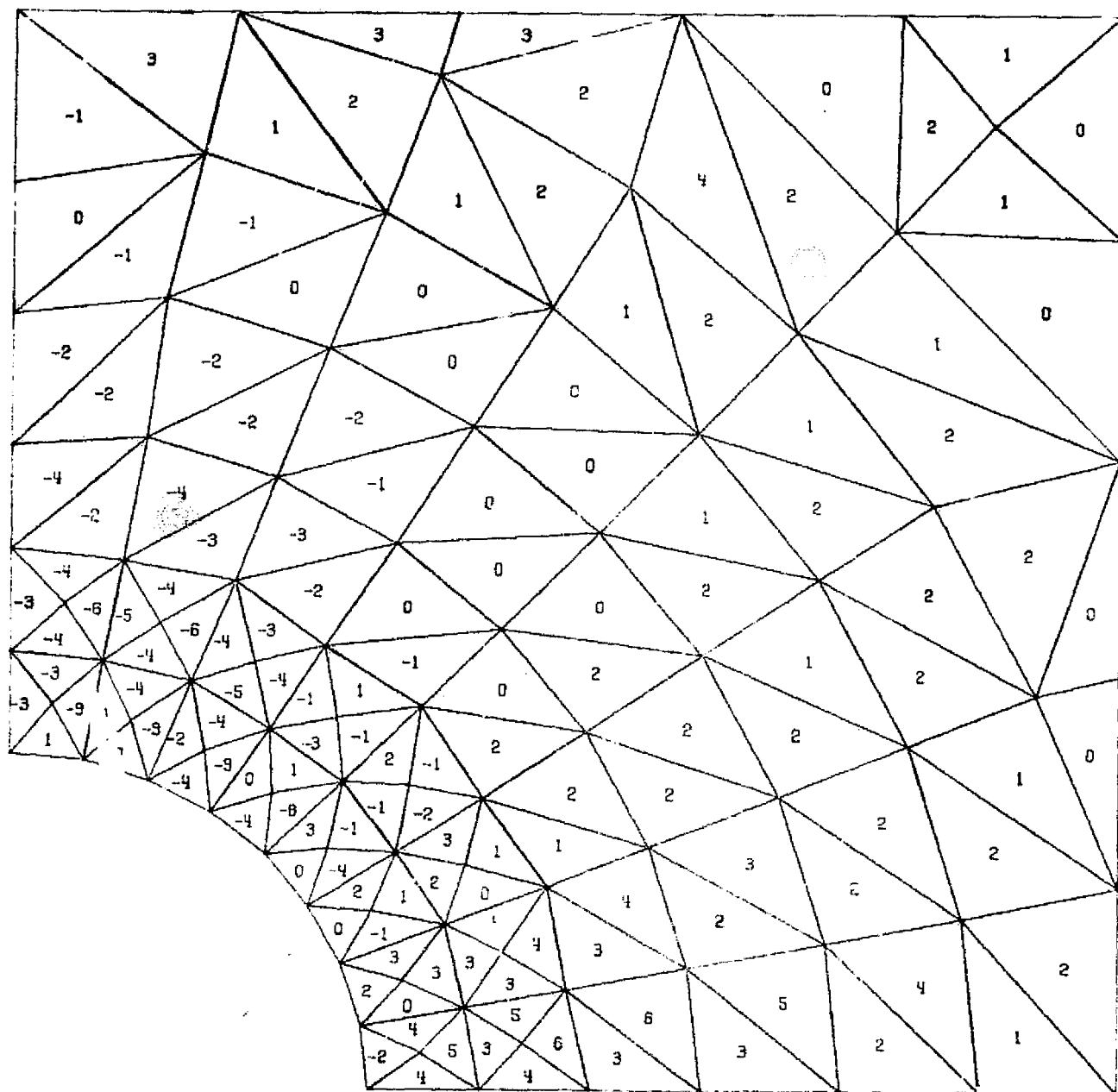
NTF 9 X 12 REINF  
CENTER TRIANGLES

0 SCALE 6

Figure 47

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

10/1/1



SPEC  
8.1

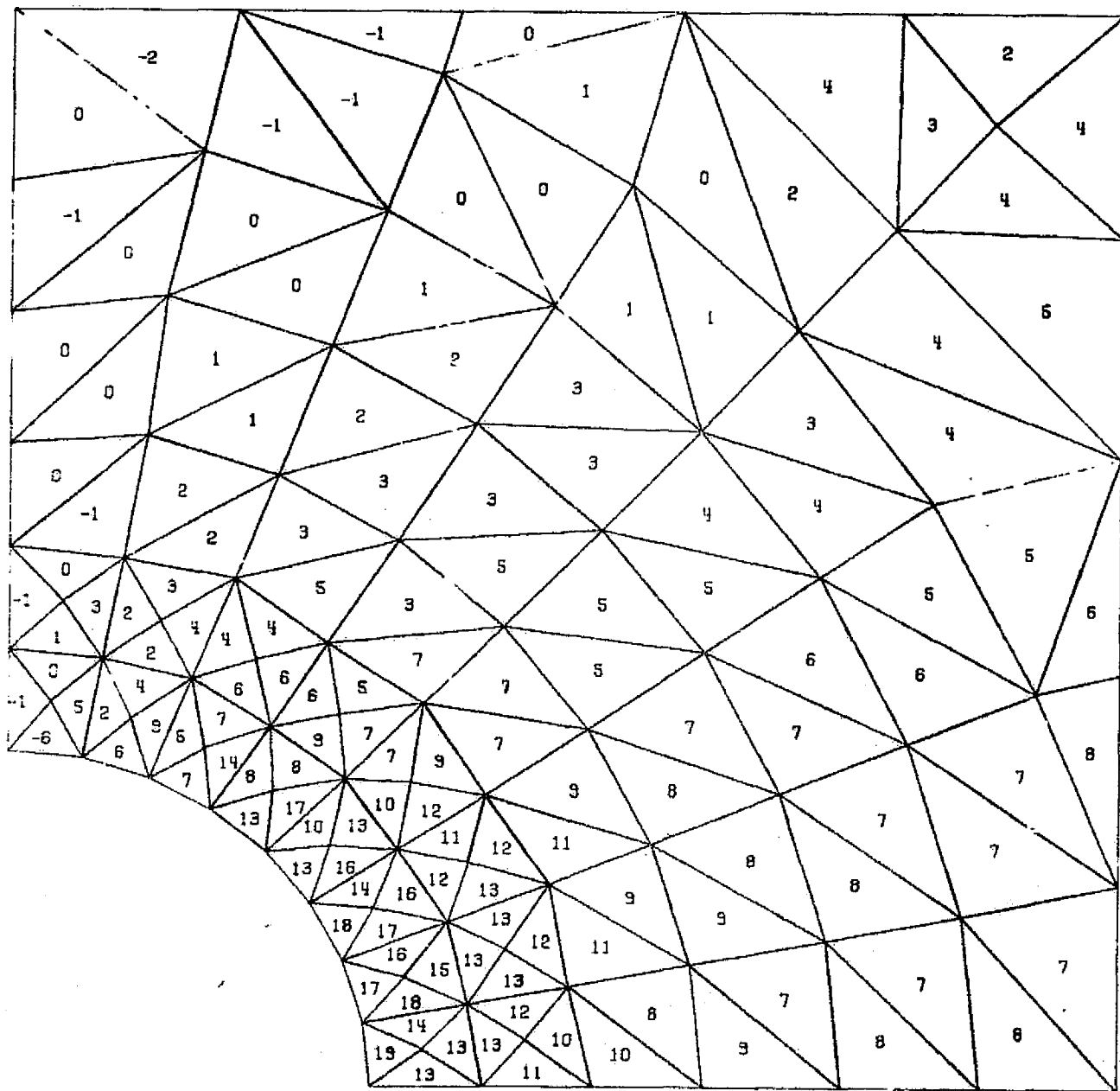
NTF 9 X 12 REINF  
CENTER TRIANGLES

0 SCALE

Figure 48

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

10/1/1



SPEC  
8.1

NTF 9 X 12 REINF  
CENTER TRIANGLES

0 SCALE 6

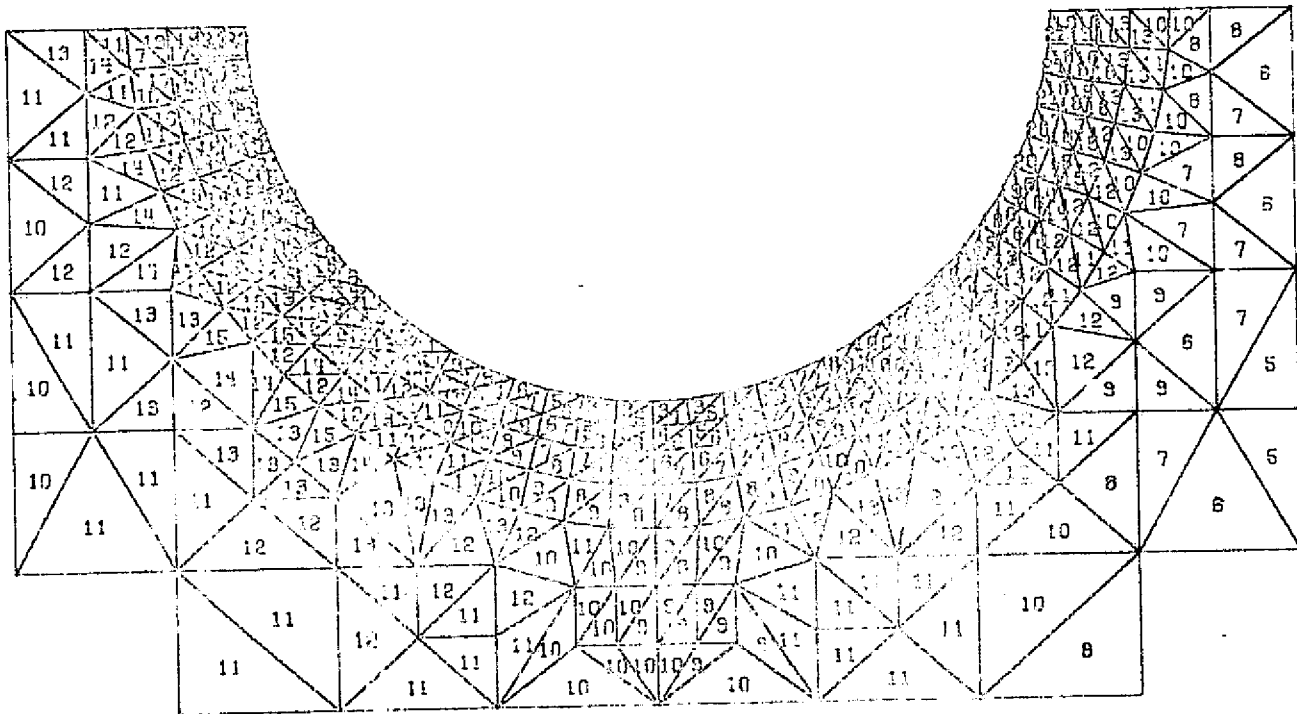
Figure 49

2-2

10/1/1

SPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

9



SPEC  
2

9 X 12 REIN WITH 9 FT HOLE  
TRIANGLES AROUND 9 FT HOLE

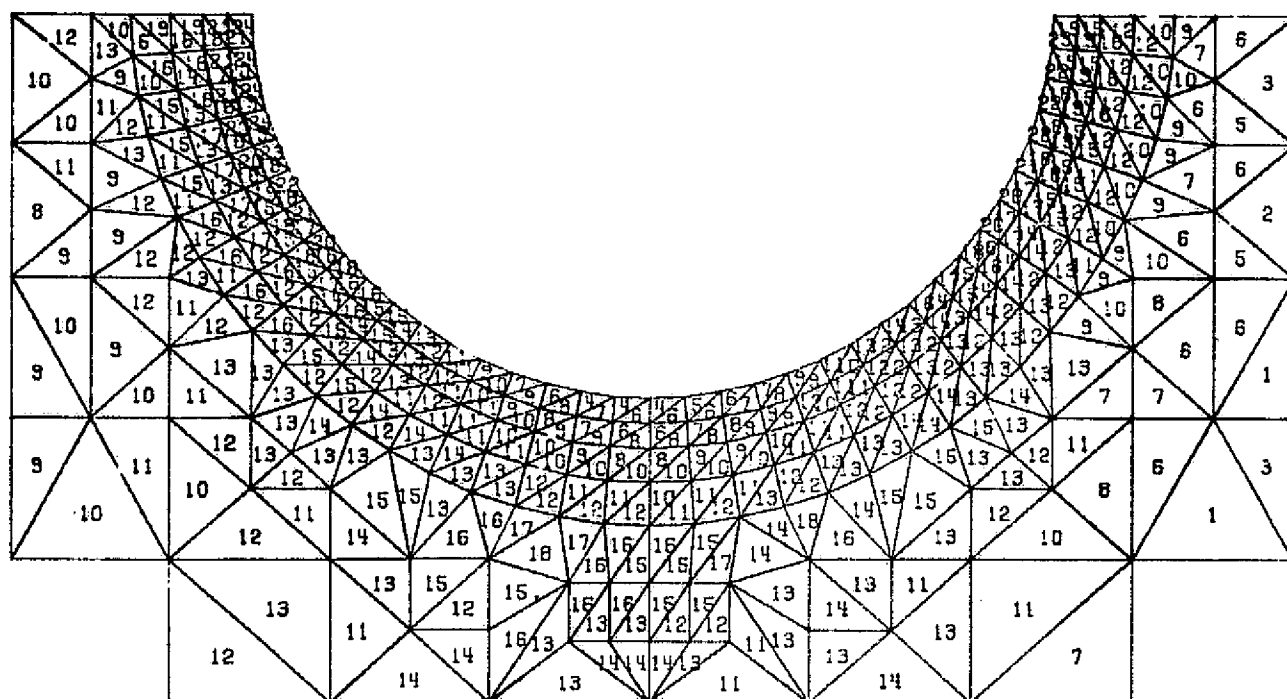
0 SCALE 24

Figure 10



DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 1

10/1/1



SPEC  
9.1

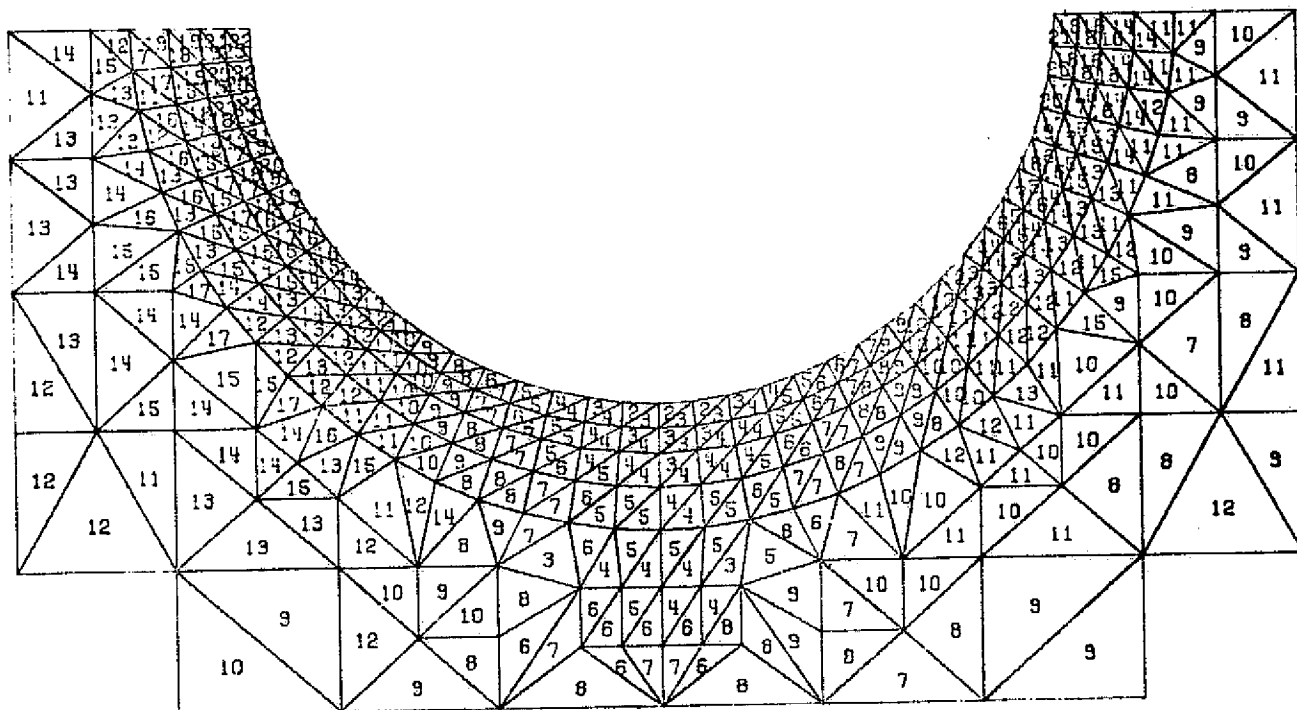
9 X 12 REINF WITH 9 FT HOLE  
TRIANGLES AROUND 9 FT HOLE

0 24  
SCALE

Figure 51

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2



REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
9.1

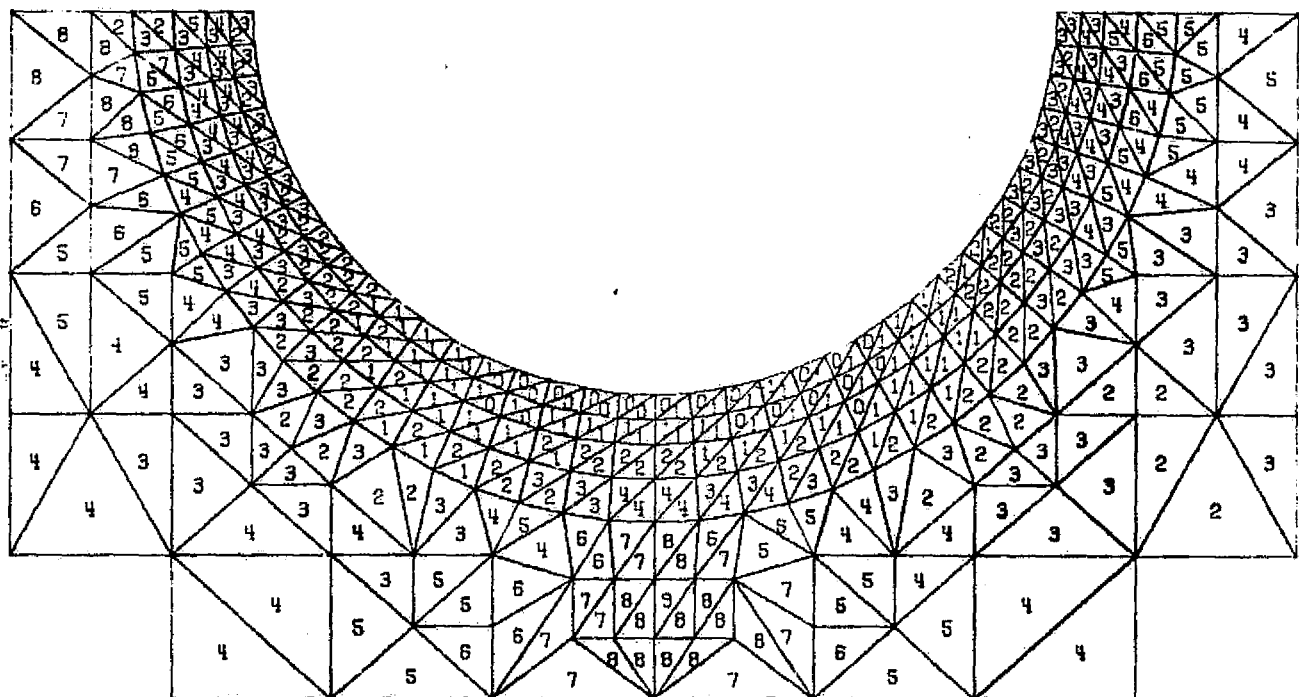
9 X 12 REINF WITH 9 FT HOLE  
TRIANGLES AROUND 9 FT HOLE

0 2  
SCALE

Figure 52

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0

10/

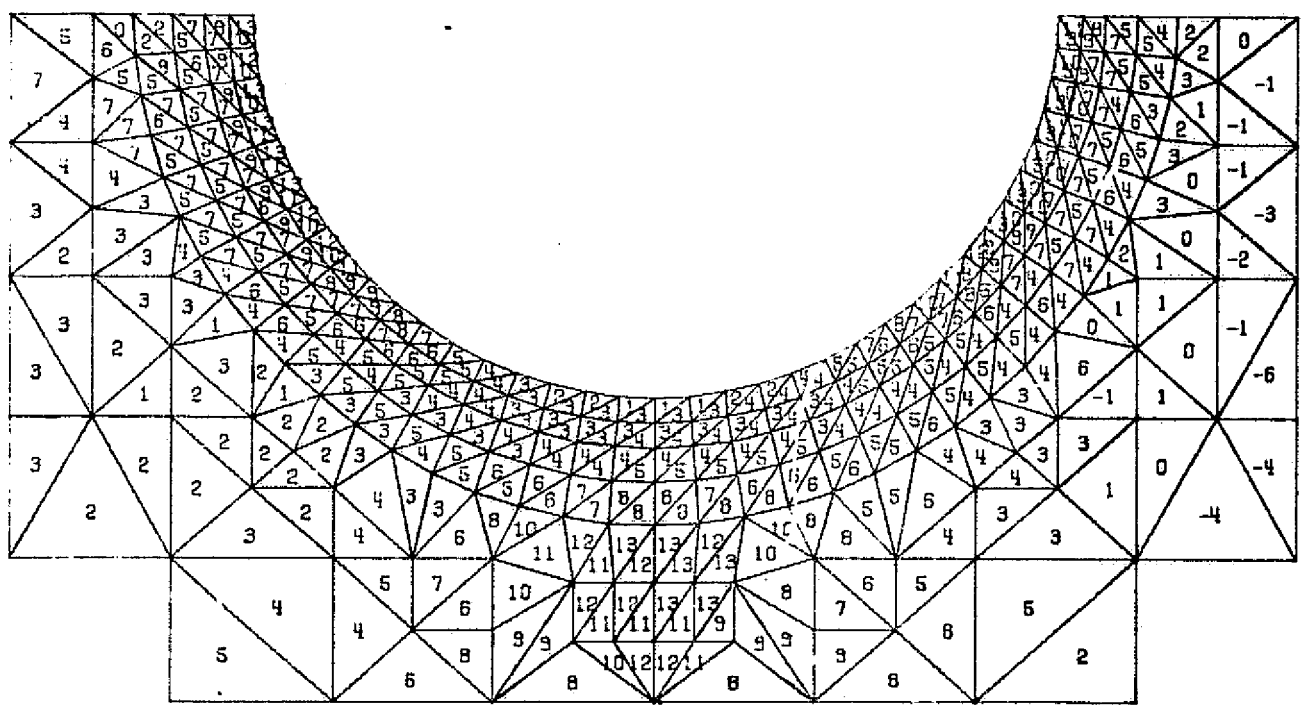


SPEC  
9.1

9 X 12 REINF WITH 9 FT HOLE  
TRIANGLES AROUND 9 FT HOLE

0  
SCALE

Figure 53



SPEC 9.1

9 X 12 REINF WITH 9 FT HOLE  
TRIANGLES AROUND 9 FT HOLE

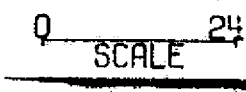
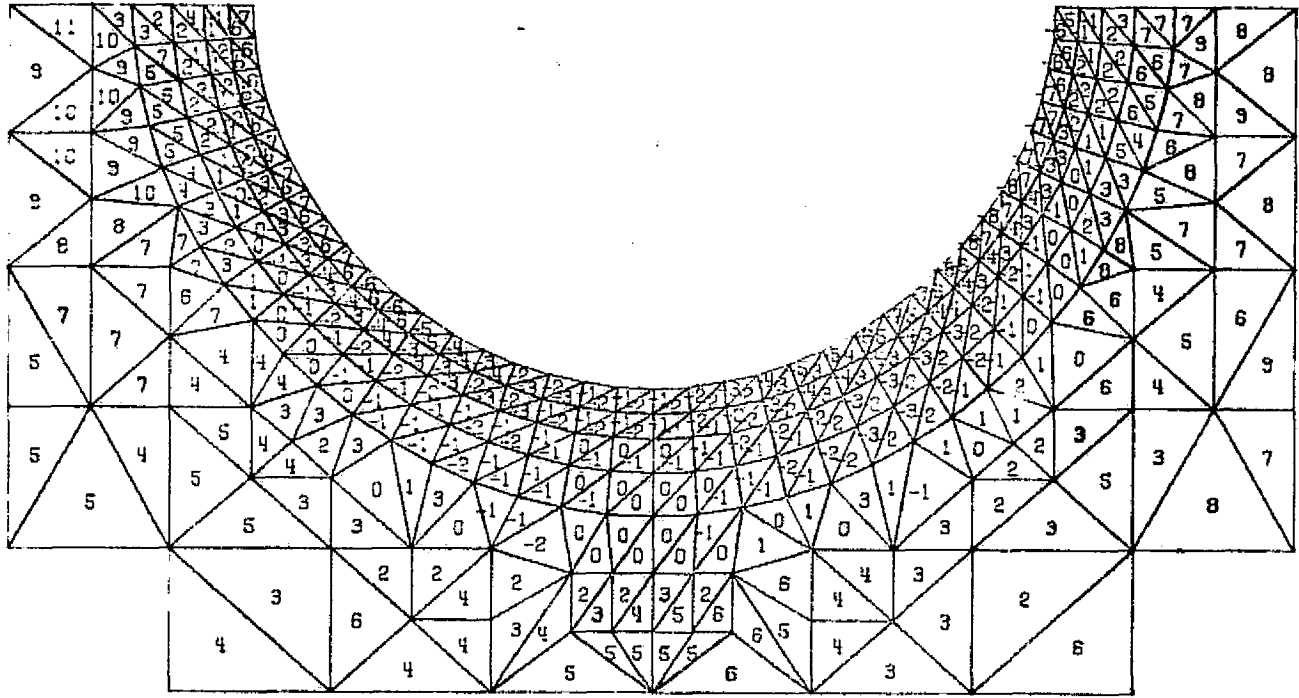


Figure 54



SPEC 9.1

9 X 12 REINF WITH 9 FT HOLE  
TRIANGLES AROUND 9 FT HOLE


0  24  
SCALE

Figure 55

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1

1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	5	5	5
2	2	3	3	3	3	4	4	4	5	6	6	7	8	9	9	10	10
3	3	3	4	4	4	5	6	7	8	9	10	11	12	13	14	15	15
2	3	3	4	6	7	9	11	12	14	15	17	18	19	20	20	21	21

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC 9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 1

0 SCALE 11

Figure 56

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1

2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4
2	2	2	2	2	1	1	1	2	2	3	3	4	5	5	6	6	7
4	4	4	4	4	5	5	6	6	7	8	9	11	12	13	13	14	14
6	5	6	7	9	10	12	14	16	17	19	20	21	21	22	22	23	22

SPEC  
10.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION I

0 SCALE 1

Figure 57

DISPLAY= PS1 /100C , NODE= 1, SURFACE= 2

10/1/1

1	1	2	2	2	3	3	4	4	5	5	6	6	7	7	8	8	8
2	3	3	4	5	6	8	9	11	12	13	14	14	15	15	15	15	15
2	2	3	3	4	4	5	6	7	8	10	11	12	13	14	15	15	16
0	0	1	2	3	4	6	7	9	11	13	14	15	16	17	18	18	20

SPEC  
10.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 1

0 SCALE

Figure 58



DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0

10/1/1

-1	-1	-1	-1	-1	0	0	1	1	2	3	3	4	4	4	5	5	5
-2	-2	-1	-1	0	0	1	2	3	3	4	4	5	5	5	5	5	5
-1	-1	-1	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2
-1	-1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1

SPEC  
10.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 1

0 SCALE

Figure 59

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

1	0	0	0	0	0	0	0	1	1	2	2	2	3	3	3	3	3
-3	-4	-4	-4	-4	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
-1	-1	-1	-1	0	0	0	1	1	1	2	2	2	2	3	3	3	3
1	2	2	4	5	6	7	9	10	11	12	12	12	13	13	13	13	12

SPEC 10.1 9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 1

0 SCALE 11

Figure 60

DISPLAY= PS2 /100C , NODE= 1, SURFACE= 2

10/1/1

-4	-3	-3	-2	-1	0	0	1	2	3	4	4	5	5	5	6	6	6
-1	0	1	2	3	4	5	6	7	8	9	10	11	11	12	13	13	14
0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0
-2	-3	-3	-4	-5	-6	-7	-8	-9	-9	-10	-10	-10	-10	-10	-10	-10	-10

SPEC  
10.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 1

0 11  
SCALE

Figure 61

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0

10/1/1

6	5	5	5	5	4	4	4	4	3	3	3	2	2	2	1	1	1
10	10	10	9	8	7	6	6	5	4	4	3	3	3	3	3	2	2
16	16	15	14	13	12	11	9	8	7	6	5	5	4	4	3	3	3
23	23	22	22	21	20	18	17	15	14	12	10	8	7	5	4	3	3

REPRODUCIBILITY OF THE  
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SPEC  
1: 1

9 X 12 REINE WITH 9 FT HOLE  
9 FT PIPE SECTION 2

0 SCALE 11

Figure 62

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 1

10/1/1

4	4	4	4	4	4	5	5	5	5	6	5	5	4	4	3	3	2
7	6	6	6	5	6	4	3	3	3	3	2	2	2	3	3	3	2
15	15	14	13	12	11	10	9	8	7	6	6	5	5	4	4	4	4
24	25	25	24	24	23	22	20	19	17	15	13	11	9	8	6	6	6

SPEC  
11.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 2

0 SCALE 11

Figure 63

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

8	8	7	7	6	5	4	3	2	1	1	0	0	0	0	0	0	0
17	17	17	16	16	15	14	12	11	9	8	6	5	4	3	3	2	2
17	17	18	15	14	12	11	9	8	7	6	5	4	3	3	2	2	2
21	21	20	19	18	17	16	14	12	11	9	7	6	4	3	2	1	0

SPEC 11.1 9 X 12 REIN WITH 9 FT HOLE  
9 FT PIPE SECTION 20 11  
SCALE

Figure 64

DISPLAY= PS2 /100C , NODE= 1, SURFACE= 0

10/1/1

5	5	5	4	4	3	3	2	2	1	1	0	-1	-1	-1	-1	-2	-2
5	5	5	5	5	5	4	4	3	2	1	1	0	-1	-1	-2	-2	-2
2	2	2	2	2	2	2	2	1	1	1	0	0	0	0	-1	-1	-1
1	1	2	2	2	2	2	1	1	1	1	1	0	0	0	0	-1	-1

SPEC  
11.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 2

0 SCALE 1

Figure 65

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

10/1/1

3	3	3	4	4	4	4	4	3	3	3	3	2	2	2	1	1	1
-6	-6	-6	-6	-5	-5	-5	-5	-4	-4	-4	-4	-4	-4	-3	-3	-3	-3
3	3	3	2	2	2	1	1	0	0	-1	-1	-2	-2	-2	-2	-2	-2
12	12	13	13	13	13	12	11	10	9	8	6	5	3	2	1	1	1

SPEC  
11.1

9 X 12 REINF WITH 9 FT HOLE  
9 FT PIPE SECTION 2

0 SCALE 11

Figure 66



DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

10/1/1

6	6	5	5	4	3	2	1	0	-1	-2	-3	-3	-4	-4	-4	-4	-4
14	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	-1	-1
1	1	1	1	2	2	2	2	3	3	2	2	2	1	1	1	0	0
-10	-10	-10	-10	-10	-9	-9	-9	-8	-7	-6	-5	-4	-3	-3	-2	-2	-2

SPEC  
11.1

9 X 12 REINE WITH 9 FT HOLE  
9 FT PIPE SECTION 2

0 SCALE

Figure 67

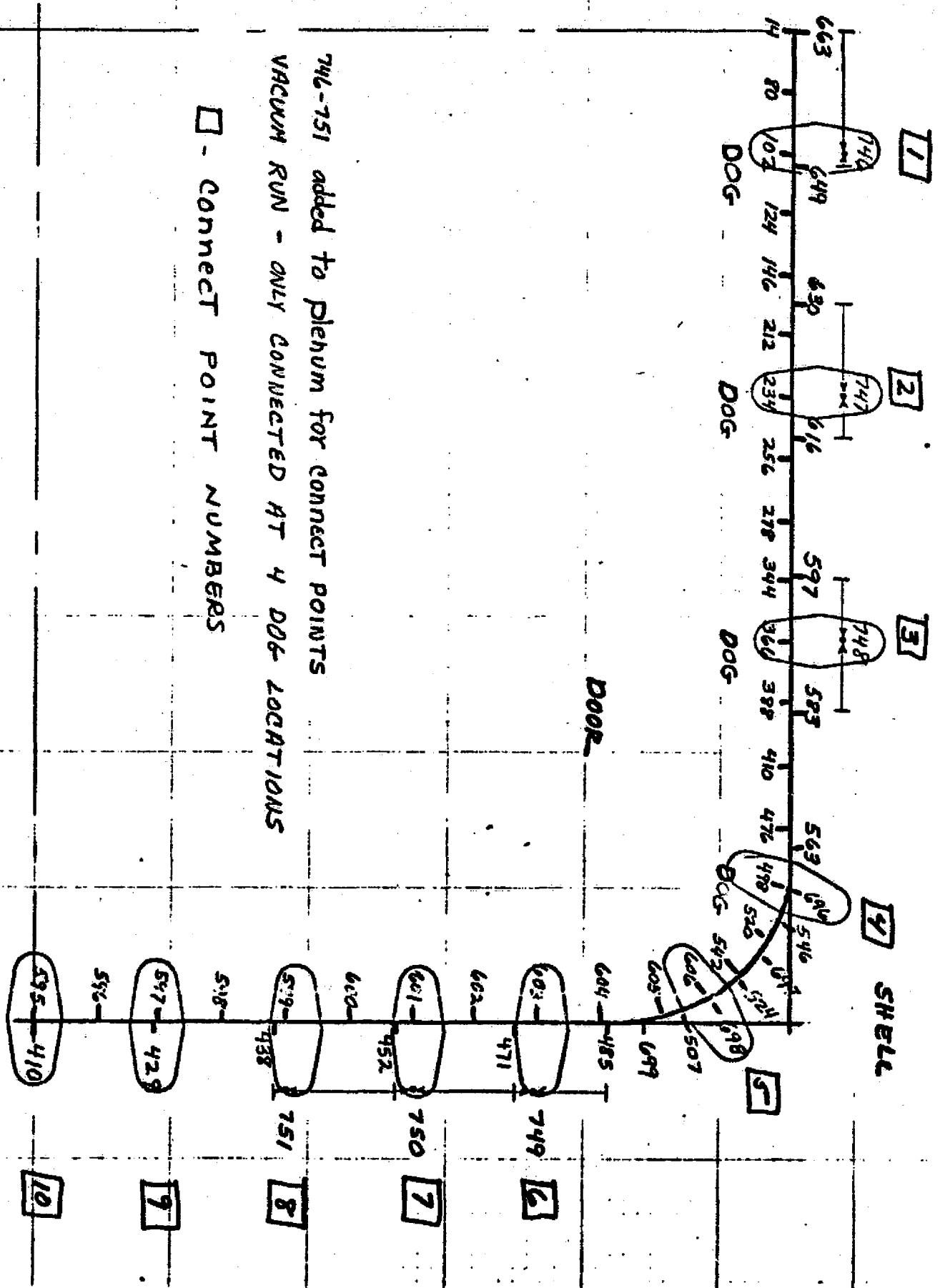
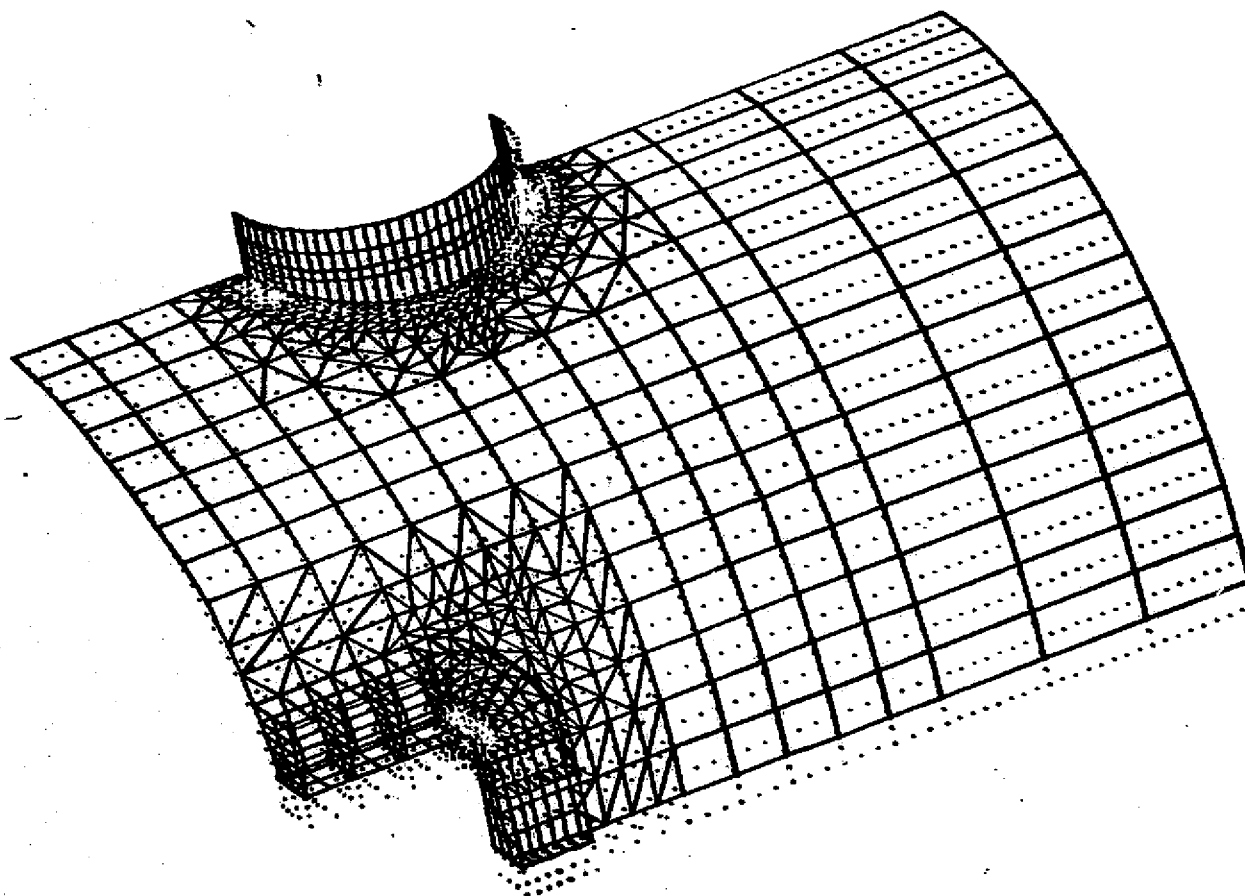


FIGURE 68

BUCKLING MODE, CRITICAL LOAD

$.119357 \times 10^{+02}$

1/7/1



SPEC  
1-1

NTF 9 X 12 ACCESS OPENING

Fig 69

0 SCALE 67

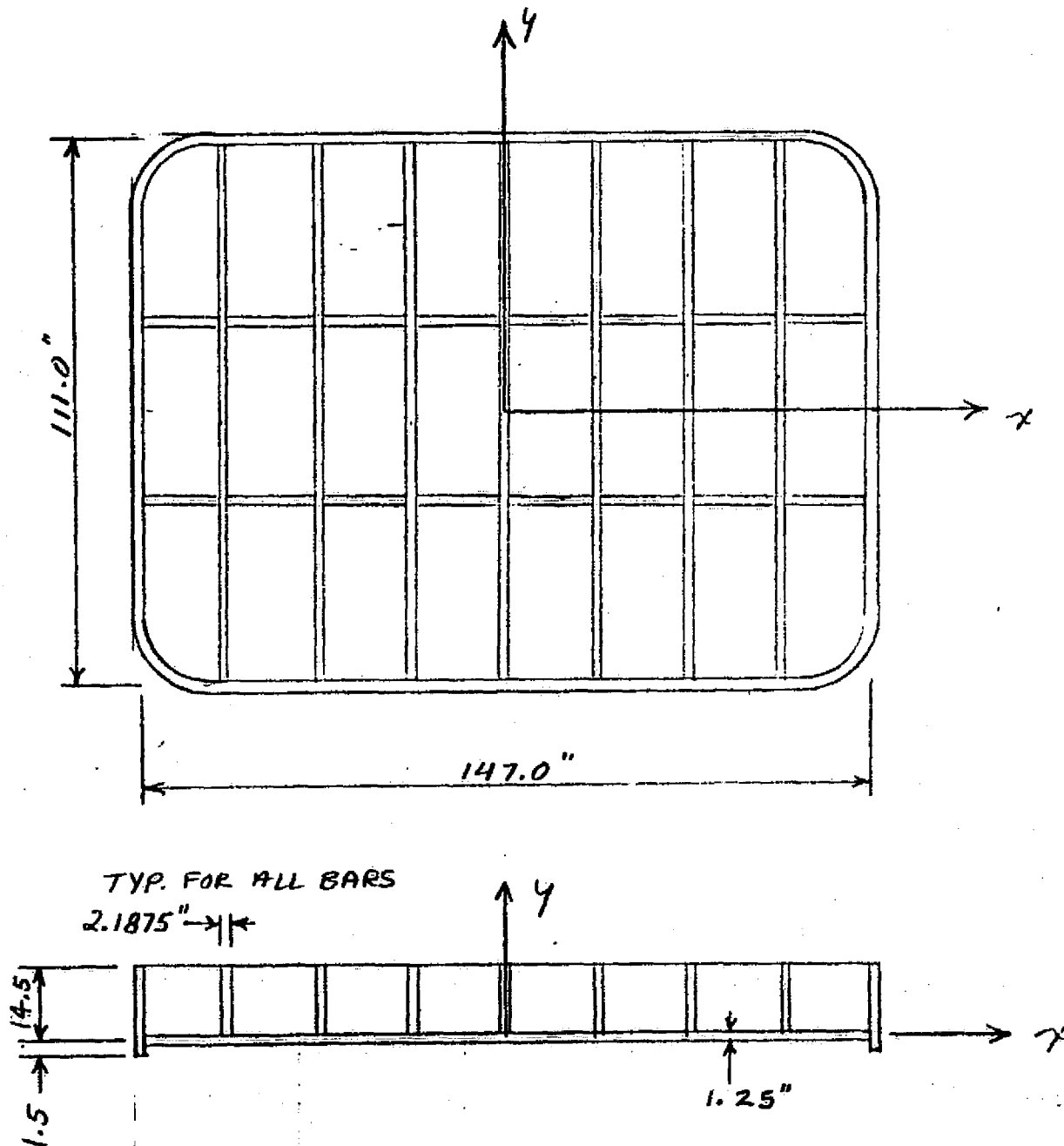
BY \_\_\_\_\_ DATE \_\_\_\_\_  
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_  
\_\_\_\_\_

SUBJECT NTF  
Finite Element Analysis of  
Side Access Door

SHEET NO. 1 OF \_\_\_\_\_  
JOB NO. \_\_\_\_\_  
\_\_\_\_\_

Port 2

Reference Drawing LE 9444715



SPAR (a finite element computer code developed + maintained by Engineering Information System, Inc. under NASA contract NAS8-30536 and NAS 1-13977) was used to analyse this region of the pressure shell. The region was modeled using, triangular and quadrilateral, membrane plus bending flat anisotropic elements

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The final configuration shown on LE is slightly different from the configuration modeled.

The plate is now the sealing surface with all the stiffener height above the plate (Total height plate + stiffener = 17") rather than a 1.5" high stiffener for the sealing surface and 14.5" high stiffeners on opposite side of the plate.

The total height (sealing stiffener + plate + stiffener) is 17.0".

It was judged that these discrepancies would have min. effect on the Door / Plenum results.

One-quarter of the door was modeled. The horizontal and vertical  $\pm$  of the door were planes of symmetry.

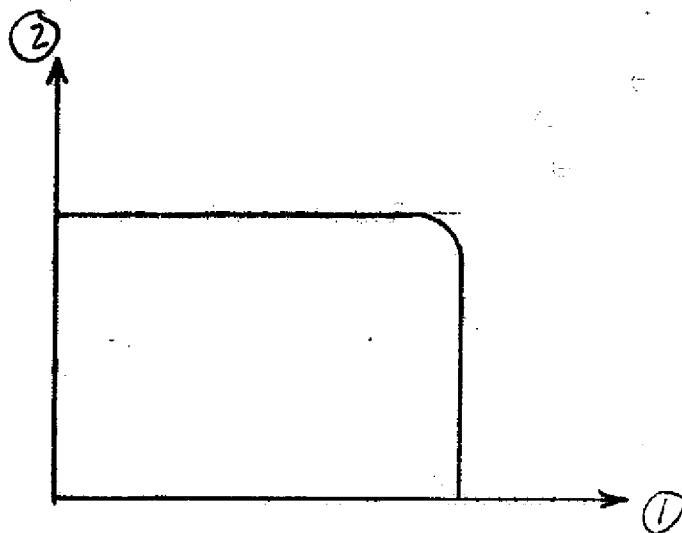
A computer plot of the door is shown in Fig 1. The model consists of 606 joints with 6 DOF at each joint except where boundary conditions were applied and rotation about an axis  $\perp$  to a plate element was restricted as required.

The joint numbers and shell section properties are shown in Fig 2 thru 11.

The section properties and thicknesses are listed below

Shell Section Property	Thickness
1	1.25
2	2.1875
3	2.1875
4	1.0938
5	2.1875
6	2.1875
7	2.1875

## Boundary Condition



Plane 1 3 is plane of symmetry

Plane 2 3 is plane of symmetry

Force displacements (in the 3 direction) obtained from combining the Door & Plenum models were applied to the edge of the Door  
See discussion on combined runs (p.



### Loading

P = 119 psi (design pressure) was applied as nodal pressure to the joints of the pressure surface.

For vacuum condition, -15 psi was applied as nodal pressure to the joints of the pressure surface.

### Combined Door + Plenum Analyses

See discussion in Finite Element Analysis of Access Door Reinforcement (Plenum), (p. 9)

## Results

Nodal stresses are presented in Fig 12 thru 69 .

The max principal stress (PS1) or min. principal stress (PS2) are given for the mid. surface ( surface 0 ), the stiffner bar side of the plate ( surface 1 ), and the sealing surface side of the plate ( surface 2 ).

The stresses plotted are for joint 1 of the element. As an example (reference Fig 2 ), for the element defined by joint 1, 67, 68, 2. joint 1 for that element is 1

Nodal stresses for one joint are given from 4 elements ( for quadrilateral elements). If any discrepancies exist in the stresses for a joint, the largest value is used in the evaluation of the results.

Membrane Stress in Plate ( $P = 119 \text{ psig}$ )

Max. at joint 1 (Fig )

$$\sigma_1 = 10.20 \text{ KSI}$$

$$\sigma_2 = 1.00 \text{ KSI}$$

$$\sigma_3 = -\frac{119}{2} = -0.06 \text{ KSI}$$

$$S_{12} = 10.20 - 1.00 = 9.20 \text{ KSI}$$

$$S_{23} = 1.00 - (-0.06) = 0.94 \text{ KSI}$$

$$S_{31} = -0.06 - 10.20 = -10.26 \text{ KSI}$$

$$P_m = |-10.26| = 10.26 \text{ KSI}$$

$$P_m < S_m$$

$$10.26 < 20.0 \text{ KSI} \quad \text{O.K.}$$

BY \_\_\_\_\_ DATE \_\_\_\_\_

SUBJECT \_\_\_\_\_

SHEET NO. 9 OF \_\_\_\_\_

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

JOB NO. \_\_\_\_\_

Bending stress in Plate ( $P = 119 \text{ psi}$ )

Max at joint 233 (not shown  
on plot)

$$\sigma_1 = 16.92 \text{ KSI}$$

$$\sigma_2 = 11.11 \text{ KSI}$$

$$\sigma_3 = -.119 \text{ KSI}$$

$$S_{12} = 16.92 - 11.11 = 5.81 \text{ KSI}$$

$$S_{23} = 11.11 - (-.12) = 11.23 \text{ KSI}$$

$$S_{31} = -.12 - 16.92 = -17.04 \text{ KSI}$$

$$P_b = |-17.04| = 17.04 \text{ KSI}$$

$$P_b \leq 1.5 S_m$$

$$17.04 \leq 1.5(20) = 30 \text{ KSI}$$

Stiffener Bar

Max stress Joint 54 (Not shown  
on plots)  
 $P = 119 \text{ psi}$

$$\sigma_1 = 0.07 \text{ KSI}$$

$$\sigma_2 = -25.87 \text{ KSI}$$

$$\sigma_3 = 0 \text{ KSI}$$

$$S_{12} = 0.07 - (-25.87) = +25.94 \text{ KSI}$$

$$S_{23} = -25.87 - 0 = -25.87 \text{ KSI}$$

$$S_{31} = 0 - 0.07 = -0.07 \text{ KSI}$$

$$P_b = |+25.94| = 25.94 \text{ KSI}$$

$$P_b \leq 1.5 S_m$$

$$25.94 < 1.5(20) = 30 \text{ KSI} \quad \text{O.K.}$$

BY.....DATE.....

SUBJECT.....

SHEET NO. 11 OF .....

CHKD. BY.....DATE.....

JOB NO. ....

For relative displacement between the sealing surfaces of the door and plenum opening for internal  $P = 119$  psi see Fig. of Finite Element Analyses of Access Door Reinforcement (Plenum).

For relative displacement between sealing surfaces of the door and plenum opening for vacuum along with dog loads under vacuum, see Fig. of Finite Element Analysis of Access Reinforcement (Plenum).

## Buckling of 9' x 12' Door Stiffener

use simple supported beam Analyses

for 18" section of door

$$M = \frac{w l^2}{8} = \left( 119 \frac{\text{lb}}{\text{in}} \right) \left( \frac{18 \text{ in}}{8} \right) \left( \frac{108 \text{ in}}{8} \right)^2 = 3.123 \times 10^6 \text{ in-lb}$$

From Roark Case 15 p 344 Sect. XV.

with ends held vertical + not fixed in Hory. plane

$$M' = \frac{\pi b^3 d \sqrt{E G \left( 1 - 0.63 \left( \frac{b}{a} \right) \right)}}{6 l}$$

$$M' = \frac{\pi (2.18)^3 (15) \sqrt{(28 \times 10^6) (11.15 \times 10^6) \left( 1 - 0.63 \left( \frac{2.18}{15} \right) \right)}}{6 (38.5)}$$

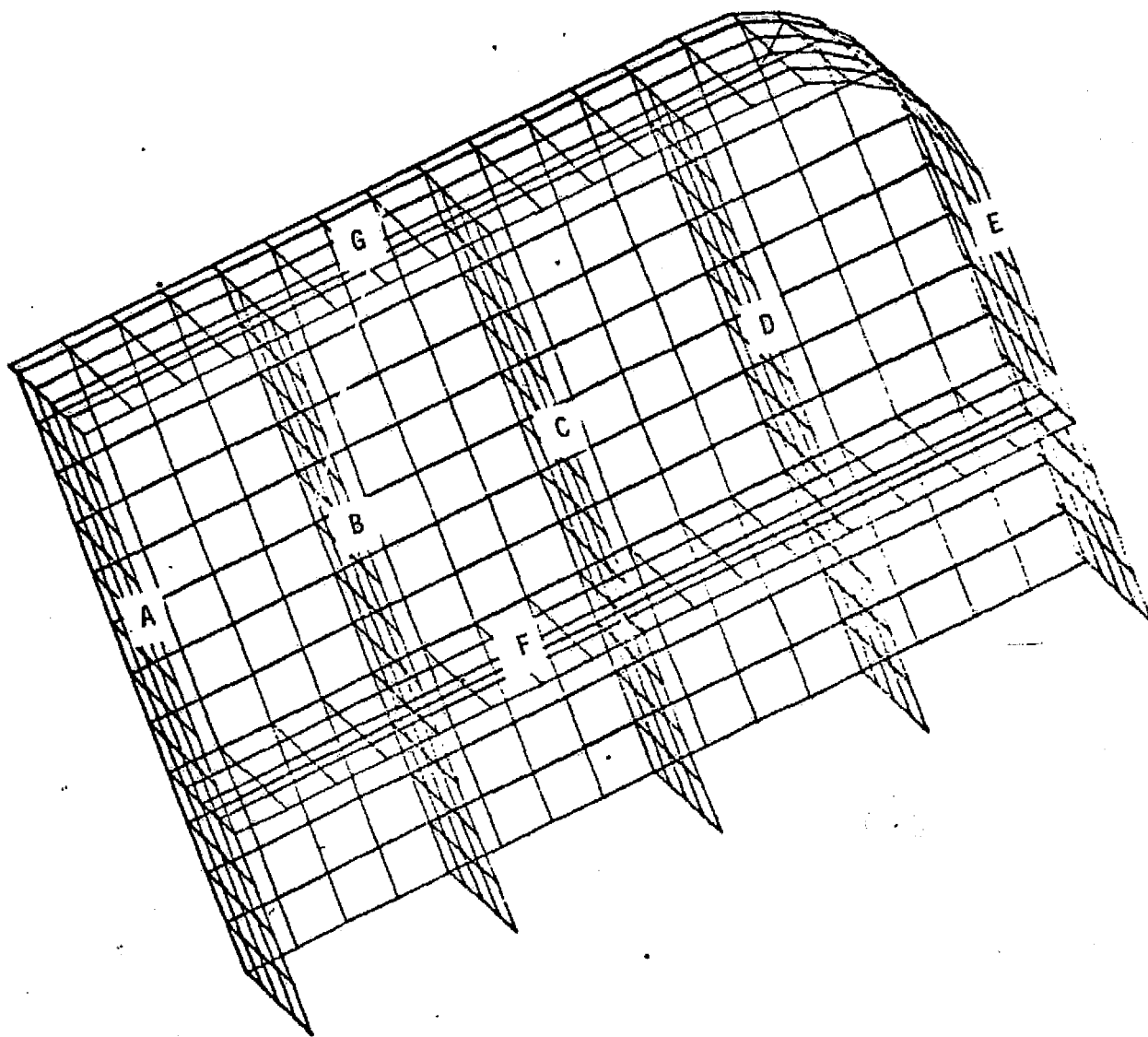
$$M' = 3.56 \times 10^7 \text{ in-lbs}$$

The applied moment is much less than the critical moment. Analysis is conservative because restraint of plat not considered.

∴ Lateral Buckling is no problem







SPEC  
1.1

NTF 9 X 12 DOORS

0 SCALE 13

Figure 1B

13	73	101	123	145	211	233	255	277	343	365	387	409	475	497	519	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	519
12	78	100	122	144	210	232	254	276	342	364	386	408	474	496	518	540
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	540
11	77	99	121	143	209	231	253	275	341	363	385	407	473	495	517	539
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	539
10	76	98	120	142	208	230	252	274	340	362	384	406	472	494	516	538
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	538
9	75	97	119	141	207	229	251	273	339	361	383	405	471	493	515	537
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	537
8	74	96	118	140	206	228	250	272	338	360	382	404	470	492	514	536
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	536
7	73	95	117	139	205	227	249	271	337	359	381	403	469	491	513	535
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	535
6	72	94	116	138	204	226	248	270	336	358	380	402	468	490	512	534
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	534
5	71	93	115	137	203	225	247	269	335	357	379	401	467	489	511	533
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	533
4	70	92	114	136	202	224	246	268	334	356	378	400	466	488	510	532
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	532
3	69	91	113	135	201	223	245	267	333	355	377	399	465	487	509	531
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	531
2	68	90	112	134	200	222	244	266	332	354	376	398	464	486	508	530
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	530
1	67	89	111	133	199	221	243	265	331	353	375	397	463	485	507	529
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	529

SPEC  
2-1

NTF 9 X 12 DOORS  
PLATE ONLY

0 SCALE 1

ELEMENT SECTION PROPERTY GROUPS

REPRODUCED FROM

REPRODUCED FROM (GRAPHIC CONTAINS COPYRIGHTED MATERIAL) REPRODUCED FROM (GRAPHIC CONTAINS COPYRIGHTED MATERIAL)

No. 00

Figure 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70

SPEC  
3.1

NTF 9 X 12 DOORS  
STIFFENER BAR A

0 SCALE 8

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

ELEMENT SECTION PROPERTY GROUPS

Figure 3

186	187	188	189	190	191	192	193	194	195	196	197	198
7	7	7	7	7	7	7	7	7	7	7	7	7
173	174	175	176	177	178	179	180	181	182	183	184	185
7	7	7	7	7	7	7	7	7	7	7	7	7
160	161	162	163	164	165	166	167	168	169	170	171	172
7	7	7	7	7	7	7	7	7	7	7	7	7
147	148	149	150	151	152	153	154	155	156	157	158	159
7	7	7	7	7	7	7	7	7	7	7	7	7
133	134	135	136	137	138	139	140	141	142	143	144	145

ELEMENT SECTION PROPERTY GROUPS

SPEC  
4.1

NTF 9 X 12 DOORS  
STIFFENER BAR B

0 8  
SCALE

Figure 4

318	319	320	321	322	323	324	325	326	327	328	329	330
7	7	7	7	7	7	7	7	7	7	7	7	7
305	306	307	308	309	310	311	312	313	314	315	316	317
7	7	7	7	7	7	7	7	7	7	7	7	7
292	293	294	295	296	297	298	299	300	301	302	303	304
7	7	7	7	7	7	7	7	7	7	7	7	7
279	280	281	282	283	284	285	286	287	288	289	290	291
7	7	7	7	7	7	7	7	7	7	7	7	7
265	266	267	268	269	270	271	272	273	274	275	276	277

SPEC  
5.1

NTF 9 X 12 DOORS  
STIFFENER BAR C

0  
SCALE

ELEMENT SECTION PROPERTY GROUPS

Figure 5

100	101	102	103	104	105	106	107	108	109	110	111	112
5	5	5	5	5	5	5	5	5	5	5	5	5
113	114	115	116	117	118	119	120	121	122	123	124	125
5	5	5	5	5	5	5	5	5	5	5	5	5
126	127	128	129	130	131	132	133	134	135	136	137	138
5	5	5	5	5	5	5	5	5	5	5	5	5
139	140	141	142	143	144	145	146	147	148	149	150	151
5	5	5	5	5	5	5	5	5	5	5	5	5
152	153	154	155	156	157	158	159	160	161	162	163	164
5	5	5	5	5	5	5	5	5	5	5	5	5

SPEC  
6.1

NTF 9 X 12 DOORS  
STIFFENER BAR D

0 SCALE 0

Figure 6

562	565	569	568	576	577	588	583	590	591	592	593	594
2	2	2	2	2	2	2	2	2	2	2	2	2
563	570	571	572	573	574	575	576	577	578	579	580	581
2	2	2	2	2	2	2	2	2	2	2	2	2
566	567	568	569	570	571	572	573	574	575	576	577	578
2	2	2	2	2	2	2	2	2	2	2	2	2
543	544	545	546	547	548	549	550	551	552	553	554	555
2	2	2	2	2	2	2	2	2	2	2	2	2
529	530	531	532	533	534	535	536	537	538	539	540	541
2	2	2	2	2	2	2	2	2	2	2	2	2
535	536	537	538	539	540	541	542	543	544	545	546	547

SPEC  
7.1

NIF 9 X 12 DOORS  
STIFFENER BAR E

0 SCALE 8

ELEMENT SECTION PROPERTY GROUPS

Figure 7

533	547	560	573	586
6	6	6	6	
511	521	523	525	527
6	6	6	6	
483	493	501	503	505
6	6	6	6	
487	477	473	481	483
6	6	6	6	
401	415	428	441	454
6	6	6	6	
373	383	391	393	395
6	6	6	6	
357	367	363	371	373
6	6	6	6	
335	345	347	343	351
6	6	6	6	
263	283	236	303	322
6	6	6	6	
247	257	253	261	263
6	6	6	6	
225	235	237	233	241
6	6	6	6	
203	213	215	217	219
6	6	6	6	
137	151	164	177	190
6	6	6	6	
115	125	127	129	131
6	6	6	6	
93	103	105	107	109
6	6	6	6	
71	81	83	85	87
6	6	6	6	
5	13	32	45	68

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
8.1.

NTF 9 X 12 DOORS  
STIFFENER BAR F

SCALE

ELEMENT SECTION PROPERTY GROUPS

Figure 8



ELEMENT SECTION PROPERTY GROUPS

542541	566	568	581	594
2 3	3 3	3 3	3 3	3 3
520519	522	524	526	528
2 3	3 3	3 3	3 3	3 3
498497	500	502	504	506
2 3	3 3	3 3	3 3	3 3
478475	478	480	482	484
2 3	3 3	3 3	3 3	3 3
410409	423	436	449	462
2 3	3 3	3 3	3 3	3 3
388387	390	392	394	396
2 3	3 3	3 3	3 3	3 3
368365	368	370	372	374
2 3	3 3	3 3	3 3	3 3
344343	346	348	350	352
2 3	3 3	3 3	3 3	3 3
278277	291	304	317	330
2 3	3 3	3 3	3 3	3 3
258255	258	260	262	264
2 3	3 3	3 3	3 3	3 3
234233	236	238	240	242
2 3	3 3	3 3	3 3	3 3
212211	214	216	218	220
2 3	3 3	3 3	3 3	3 3
146145	153	172	185	198
2 3	3 3	3 3	3 3	3 3
124123	126	128	130	132
2 3	3 3	3 3	3 3	3 3
102101	104	106	108	110
2 3	3 3	3 3	3 3	3 3
8079	82	84	86	88
2 3	3 3	3 3	3 3	3 3
1413	27	40	53	66

SPEC  
9.1

NTF 9 X 12 DOORS  
STIFFENER BAR G

0 11  
SCALE

No. 00

Figure 9

542541
2
520513
2
438497
2
478475
2
410403
2
388387
2
368365
2
344343
2
278277
2
256255
2
234233
2
212211
2
146145
2
124123
2
102101
2
8079
2
1413

SPEC  
10.1

NTF 9 X 12 DOORS  
SEAL FLANGE - TOP

0 SCALE 11

Figure 10

S29	S30	S31	S32	S33	S34	S35	S36	S37	S38	S39	S40	S41
595 2	596 2	597 2	598 2	599 2	600 2	601 2	602 2	603 2	604 2	605 2	606 2	642

SPEC  
11.1

NIF 9 X 12 DOORS  
SEAL FLANGE - SIDE

0 SCALE 8

ALBERT SECTION PROPERTY GROUPS

Figure 11

DISPLAY= PS1 /1000 . NODE= 1 . SURFACE= 0

10/1/1

1	2	1	2	2	2	1	1	3	3	2	1	2	2	1	1
3	2	2	3	4	3	2	2	4	3	2	2	3	2	2	1
5	4	3	4	6	4	3	3	5	4	3	2	4	3	2	2
6	5	4	5	6	5	4	4	6	4	4	3	4	4	3	2
7	6	6	6	7	6	5	5	6	5	4	4	5	4	3	3
8	7	6	7	8	6	6	6	7	6	5	4	5	4	4	3
8	8	7	7	8	7	6	6	7	6	5	5	6	6	4	4
9	8	8	8	9	8	7	7	7	6	5	5	6	6	6	4
9	9	9	9	9	8	8	7	7	7	6	5	4	4	4	3
10	9	9	9	9	9	8	8	8	7	6	5	5	4	4	3
10	10	9	9	10	9	8	8	8	7	6	5	5	4	4	3
10	10	9	9	10	9	8	8	8	7	7	6	5	4	4	3

SPEC 2.1 NTF 9 X 12 DOORS  
PLATE ONLY

0 SCALE 11

Figure 12

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1

2	1	0	2	2	1	0	2	3	1	0	1	3	0	1	0
3	-1	-1	1	3	-1	-1	1	3	0	-1	0	8	-1	-1	3
11	1	0	2	12	1	0	2	11	1	-1	1	11	0	-2	0
12	3	1	3	12	3	1	2	12	2	0	2	12	1	-2	0
12	4	2	3	12	3	1	3	12	3	1	2	12	1	-1	1
11	4	2	4	11	4	1	3	11	4	1	2	11	2	-1	1
9	6	4	4	9	6	3	3	8	5	2	2	7	4	1	2
6	9	13	8	6	9	12	8	4	9	11	7	3	10	12	6
10	6	6	6	10	6	4	6	8	3	3	4	5	1	1	3
11	5	5	6	11	4	4	5	9	3	2	4	8	0	0	2
12	6	6	7	11	6	4	6	10	4	3	4	10	1	0	1
12	7	5	7	11	6	4	6	10	5	3	4	11	2	0	1

SPEC  
2.1

NTF 9 X 12 DOORS  
PLATE ONLY

0 SCALE 11

Figure 13

DISPLAY= PS1 /1000 , NODE= 1. SURFACE= 2

10/1/1

1	3	4	2	2	4	4	1	2	4	4	1	2	4	2	2	1
0	6	6	4	0	6	6	3	1	6	6	3	0	6	5	3	2
2	6	7	6	2	7	7	6	1	6	8	4	0	6	8	4	
3	7	8	7	3	7	8	6	2	7	8	5	1	6	9	4	
4	8	9	8	4	8	9	7	3	7	9	6	1	7	9	5	
6	9	11	10	6	9	10	9	6	8	9	7	3	7	9	5	
8	9	11	11	8	8	10	9	7	7	9	8	5	6	7	6	
13	7	3	8	12	6	2	6	11	6	1	3	8	2	-1	3	
9	12	12	11	8	12	11	10	7	10	9	7	4	7	6	3	
8	14	14	12	8	13	12	10	6	11	10	8	3	9	8	4	
9	13	14	12	8	12	13	10	7	10	10	8	4	8	9	4	
9	13	14	12	8	12	13	11	7	10	10	8	4	7	9	4	

PRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
2.1

NTF 9 X 12 DOORS  
PLATE ONLY

0 11  
SCALE

Figure 14

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 0

10/1/

-2	-1	-1	-1	-3	-2	-1	0	-3	-2	-1	0	-2	-1	-1	-1
-2	-1	0	-1	-2	-1	0	0	-2	-1	-1	0	-2	-1	-1	-1
-1	0	0	-1	-2	-1	0	0	-2	-1	0	0	-1	-1	0	0
-1	0	0	0	-1	0	0	0	-1	0	0	0	-1	-1	0	0
0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
0	1	1	0	0	1	1	1	0	1	1	1	0	0	0	-1
0	1	1	1	0	1	1	1	1	1	1	1	0	0	0	0
1	1	1	1	1	1	2	2	1	1	2	2	1	0	0	-1
1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0

SPEC  
2.1

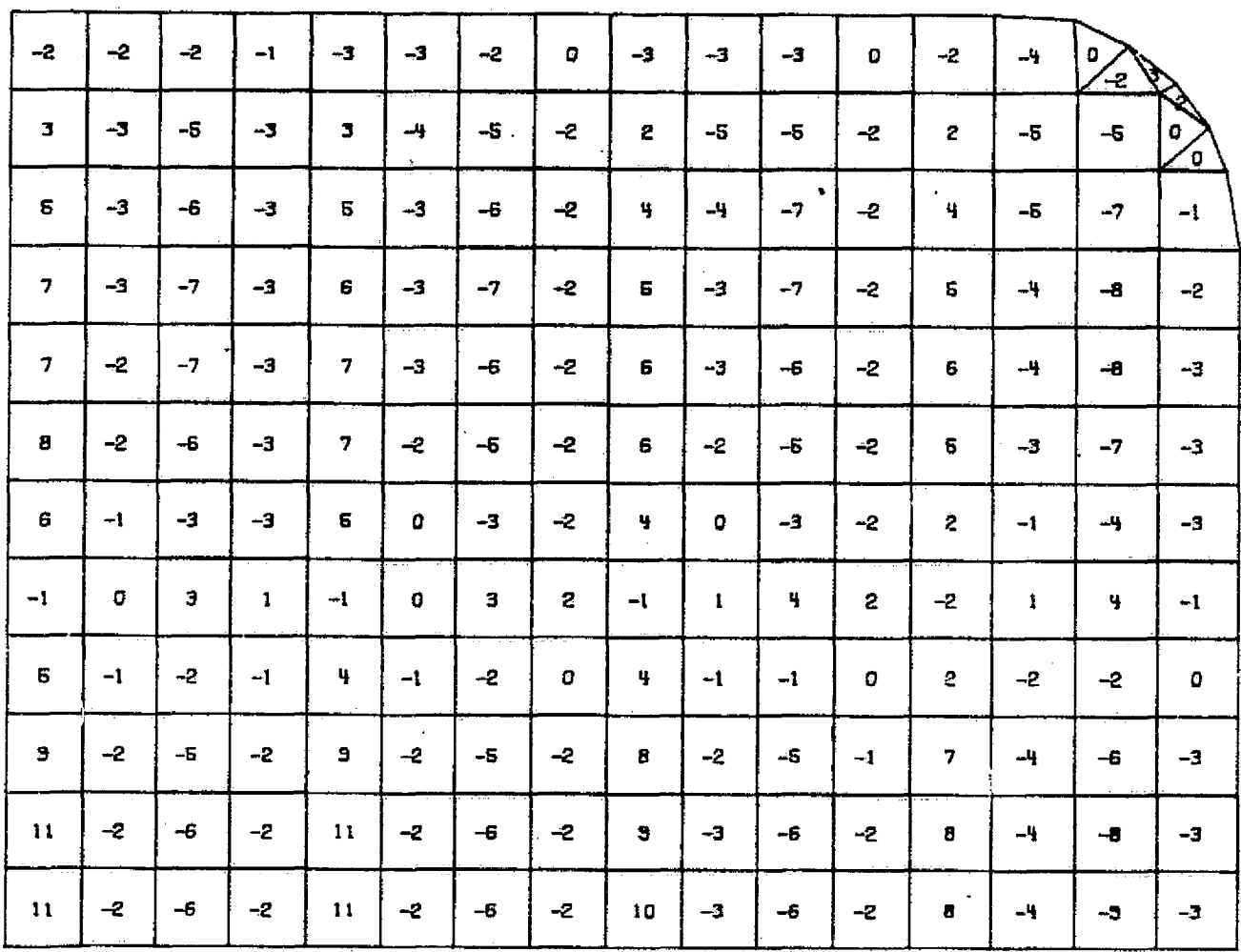
NTF 9 X 12 DOORS  
PLATE ONLY

0 SCALE

Figure 15

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 1
 

10 / 1 / 1



SPEC 2.1
 NTF 9 X 12 DOORS  
 PLATE ONLY
 

0
 

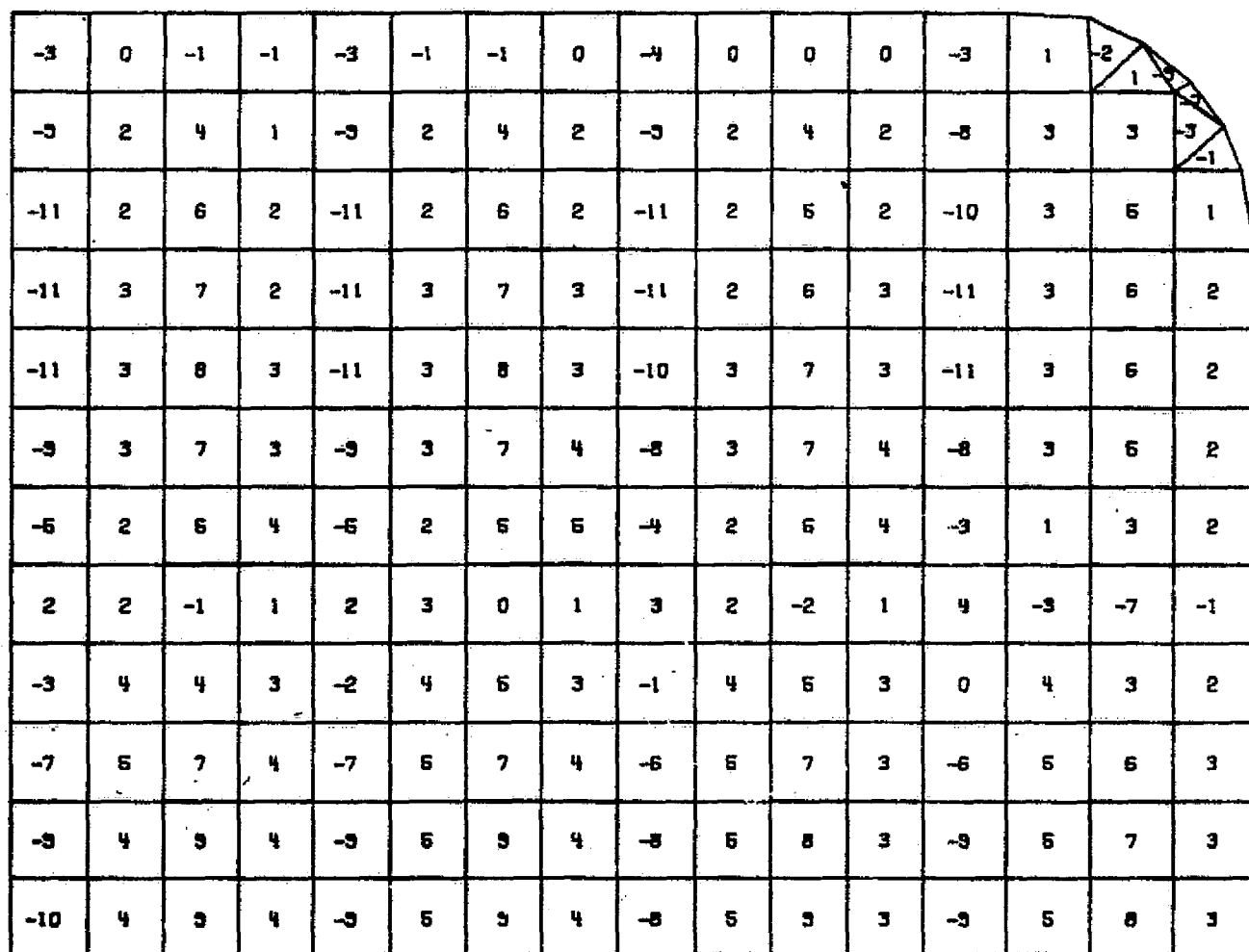
11

 SCALE

Figure 16



10 / 1 /



**SPEC  
2.1**

NTF 9 X 12 DOORS  
PLATE ONLY

Q                      SCALE

Figure 17

10/1/1

DISPLAY= PS1 /1000 . NODE= 1 . SURFACE= 0

0	0	0	0	-2	1	0	0	1	1	1	2
0	0	0	0	0	1	1	1	2	2	3	3
1	2	2	2	3	3	3	4	4	4	5	4
10	10	10	9	9	9	8	8	7	6	6	4

SPEC  
3.1

NTF 9 X 12 DOORS  
STIFFENER BAR A

0 SCALE 8

Figure 18

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

0	0	0	0	-2	1	0	0	1	1	1	2
0	0	0	0	0	1	1	1	2	2	3	3
1	2	2	2	3	3	3	4	4	4	5	4
10	10	10	3	3	3	6	6	7	6	6	4

SPEC  
3.1

NTF 9 X 12 DOORS  
STIFFENER BAR A

0 SCALE

Figure 19

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

10/1/1

0	0	0	0	-2	1	0	0	1	1	1	2
0	0	0	0	0	1	1	1	2	2	3	3
1	2	2	2	3	3	3	4	4	4	5	4
10	10	10	9	9	9	8	8	7	6	6	4

SPEC  
3.1

NTF 9 X 12 DOORS  
STIFFENER BAR A

0 SCALE 8

Figure 20

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 0

10' / 1 / 1

-17	-16	-16	-15	-14	-13	-12	-10	-8	-6	-4	-2
-8	-8	-7	-7	-7	-7	-6	-6	-5	-5	-4	-4
0	0	0	-1	-1	-2	-2	-2	-3	-3	-4	-4
1	1	1	0	1	0	0	-1	-1	-2	-3	-4

SPEC  
3.1

NTF 9 X 12 DOORS  
STIFFENER BAR A

0 SCALE 8

Figure 21

DISPLAY= PS2 /1000 . NODE= 1. SURFACE= 1

10/1/1

REPRODUCIBILITY OF THE  
ORIGINAL DATA IS POOR

-17	-16	-15	-15	-14	-13	-12	-10	-8	-6	-4	-2
-8	-8	-7	-7	-7	-7	-6	-6	-5	-5	-4	-4
0	0	0	-1	-1	-2	-2	-2	-3	-3	-4	-4
1	1	1	0	1	0	0	-1	-1	-2	-3	-4

SPEC  
3.1

NTF 9 X 12 DOORS  
STIFFENER BAR A.

0 SCALE 8

Figure 22

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 2

-17	-16	-16	-15	-14	-13	-12	-10	-8	-6	-4	-2
-8	-8	-7	-7	-7	-7	-6	-6	-5	-5	-4	-4
0	0	0	-1	-1	-2	-2	-2	-3	-3	-4	-4
1	1	1	0	1	0	0	-1	-1	-2	-3	-4

SPEC  
3.1

NTF 9 X 12 DOORS  
STIFFENER BAR A

0 SCALE

Figure 23

000000  
DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1

0	0	0	0	-2	1	0	0	1	1	1	1
0	0	0	0	0	1	1	1	2	2	3	3
1	1	2	2	2	3	3	4	4	4	4	4
10	10	3	3	3	8	8	7	7	6	5	4

SPEC  
4.1

NTF 9 X 12 DOORS  
STIFFENER BAR B

0 ——— 8  
SCALE

Figure 24



10/1/1

DISPLAY= PS1 /1000 . NODE= 1 . SURFACE= 1

0	0	0	0	-1	1	0	1	1	1	1	1
0	0	0	0	0	1	1	1	2	2	3	3
1	2	2	2	2	3	3	4	4	4	4	4
10	10	3	3	8	8	8	7	7	6	5	4

SPEC  
4.1

NTF 9 X 12 DOORS  
STIFFENER BAR B

0 SCALE 8

Figure 25

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

10/1/1

0	0	0	0	-2	0	0	0	1	1	1	2
0	0	0	0	0	0	1	1	2	2	3	3
1	1	2	2	2	3	3	4	4	4	4	4
10	5	3	3	3	8	8	7	7	6	5	4

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
4.1

NTF 9 X 12 DOORS  
STIFFENER BAR B

0 SCALE 8

Figure 26

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

10 / 1 / 1

-16	-16	-16	-14	-14	-13	-11	-10	-8	-6	-4	-2
-7	-7	-7	-7	-7	-6	-6	-5	-5	-5	-4	-4
0	0	0	-1	-1	-2	-2	-2	-3	-3	-4	-4
1	1	1	0	1	0	0	0	-1	-1	-2	-4

SPEC  
4.1

NTF 9 X 12 DOORS  
STIFFENER BAR B

0 SCALE

Figure 27

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

10/1/1

-16	-16	-15	-15	-12	-12	-11	-10	-8	-6	-4	-3
-7	-7	-7	-7	-6	-6	-6	-5	-5	-5	-4	-4
1	0	0	-1	-1	-1	-2	-2	-3	-3	-4	-4
1	1	1	0	0	0	0	0	-1	-1	-2	-4

SPEC  
4.1

NTF 9 X 12 DOORS  
STIFFENER BAR B

0 8  
SCALE

Figure 28

DISPLAY= PS2 /1000 , NODE= 1. SURFACE= 2

10/1/1

-16	-16	-15	-14	-13	-13	-12	-10	-8	-6	-4	-2
-7	-7	-7	-7	-7	-7	-6	-5	-5	-5	-4	-3
0	0	0	-1	-1	-2	-2	-2	-3	-3	-4	-4
1	1	0	0	1	0	0	0	-1	-2	-3	-4

SPEC  
4.1

NTF 9 X 12 DOORS  
STIFFENER BAR B

0 SCALE 8

Figure 29

DISPLAY= PS1 /1000 . NODE= 1. SURFACE= 0

10/1/1

0	0	0	0	-1	0	0	0	0	1	1	1
0	0	0	0	0	0	1	1	1	2	2	3
1	1	2	2	2	2	3	3	3	4	4	4
8	8	8	7	7	7	7	6	6	5	5	3

SPEC  
5.1

NTF 9 X 12 DOORS  
STIFFENER BAR C

0 8  
SCALE

Figure 30

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1

0	0	0	0	0	1	0	0	1	1	1	1
0	0	0	0	0	1	1	1	2	2	2	2
1	2	2	2	2	3	3	3	3	4	4	3
8	8	8	7	5	7	7	6	6	5	5	3

SPEC  
5.1

NTF 9 X 12 DOORS  
STIFFENER BAR C

0 8  
SCALE

Figure 31

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

10/1/1

0	0	0	1	-2	0	0	0	0	1	1	2
0	0	0	0	0	0	1	1	1	2	3	3
1	1	1	2	2	2	2	3	3	4	4	4
8	8	7	7	8	6	6	6	6	5	4	3

SPEC  
5.1

NTF 9 X 12 DOORS  
STIFFENER BAR C

0 SCALE 8

Figure 32



DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0

10/1/1

-13	-13	-13	-12	-11	-11	-9	-8	-7	-6	-3	-2
-6	-6	-6	-6	-5	-5	-5	-4	-4	-4	-4	-3
0	0	0	-1	-1	-1	-1	-2	-2	-3	-3	-4
1	1	1	0	0	0	0	0	-1	-1	-2	-3

SPEC  
5.1

NTF 9 X 12 DOORS  
STIFFENER BAR C

0 SCALE 8

Figure 33

10/1/1

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 1

-13	-13	-13	-12	-8	-9	-9	-8	-7	-5	-4	-4
-6	-6	-6	-6	-4	-4	-4	-4	-4	-4	-4	-4
1	0	0	-1	-1	-1	-1	-2	-2	-3	-3	-4
1	1	1	0	0	0	0	0	0	-1	-2	-4

SPEC  
5.1

NTF 9 X 12 DOORS  
STIFFENER BAR C

0 SCALE 8

Figure 34

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 2

10/1/1

-13	-13	-13	-12	-14	-12	-10	-9	-7	-6	-3	-1
-6	-6	-5	-6	-7	-6	-5	-5	-4	-4	-3	-2
0	0	-1	-1	0	-2	-2	-2	-2	-3	-3	-5
0	0	0	0	1	0	0	0	-1	-1	-2	-1

SPEC  
5.1

NTF 9 X 12 DOORS  
STIFFENER BAR C

0 SCALE

Figure 35

DISPLAY= PS1 /1000 . NODE= 1. SURFACE= 0

10/1/1

0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	1	1	1	2	2
1	1	2	2	1	1	1	2	2	3	3	3
6	6	5	4	4	4	5	4	4	4	3	2

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
S.1 NTF 9 X 12 DOORS  
STIFFENER BAR 0

0 8  
SCALE

Figure 36

DISPLAY= PS1 /1000 . NODE= 1 . SURFACE= 1

10/1/1

0	0	0	0	0	1	0	0	0	0	0	0
1	1	0	0	0	1	1	1	1	1	2	1
2	2	2	2	0	2	2	2	3	3	3	2
6	6	6	5	1	5	5	5	4	4	4	2

SPEC  
6.1

NTF 9 X 12 DOORS  
STIFFENER BAR D

0 ——— 8  
SCALE

Figure 37

DISPLAY= PS1 /1000 . NODE= 1. SURFACE= 2

10/1/1

0	0	0	1	-1	-1	0	0	0	1	1	2
0	0	0	1	0	0	0	0	1	1	2	3
1	1	1	2	2	0	1	2	2	2	3	3
5	5	5	4	7	4	4	4	4	4	3	2

SPEC  
6.1

NTF 9 X 12 DOORS  
STIFFENER BAR D

0 SCALE 8

Figure 38

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 0

10/1/1

-8	-8	-8	-7	-7	-7	-6	-6	-5	-4	-2	-2
-4	-4	-4	-4	-3	-3	-3	-3	-3	-3	-3	-2
1	0	0	-1	0	0	0	-1	-1	-2	-2	-2
1	1	1	0	0	0	1	0	0	0	-1	-2

SPEC  
6.1

NTF 9 X 12 DOORS  
STIFFENER BAR D

0 8  
SCALE

Figure 39

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1

10/1/1

-8	-8	-8	-8	-3	-4	-5	-5	-5	-4	-4	-4
-3	-3	-3	-4	-2	-1	-2	-2	-2	-3	-3	-4
1	1	0	-1	-1	0	0	0	-1	-1	-2	-3
2	2	2	1	0	1	1	0	0	0	0	-2

SPEC  
6.1

NTF 9 X 12 DOORS  
STIFFENER BAR D

0 ————— 8  
SCALE

Figure 40



DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

10/1/1

-9	-9	-8	-7	-11	-9	-7	-6	-6	-3	-1	0
-4	-4	-4	-3	-5	-5	-4	-3	-3	-2	-2	-1
0	0	-1	-1	1	-1	-1	-1	-1	-2	-2	-2
0	0	0	-1	0	0	1	0	0	-1	-2	-2

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
6.1

NTF 9 X 12 DOORS  
STIFFENER BAR D

0 SCALE 8

Figure 41

DISPLAY= PS1 /1000 , NODE= 1. SURFACE= 0 10/1/1

0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	0	1	0	0	0
1	1	1	2	2	2	2	1	1	1	1	1
1	1	1	3	3	2	3	3	3	2	2	2
1	2	3	4	2	4	1	5	6	3	4	3

SPEC 7.1 NTF 9 X 12 DOORS  
STIFFENER BAR E

0 8  
SCALE

Figure 42

DISPLAY= PS1 /1000 . NODE= 1. SURFACE= 1

10/1/1

2	2	1	0	3	2	1	0	0	-1	-1	-2
2	2	2	1	1	2	2	2	2	1	0	0
2	2	3	2	0	3	3	3	4	3	2	2
4	4	3	4	-1	3	5	5	7	5	4	4
1	2	2	4	5	4	1	5	5	2	3	2

SPEC  
7.1

NIE 9 X 12 DOORS  
STIFFENER BAR E

0 SCALE

Figure 43

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1

0	0	0	1	0	-1	-1	0	0	2	3	4
-1	-1	0	2	0	-1	-1	-1	0	1	2	3
-1	-1	0	2	3	0	0	0	-1	0	1	1
-1	0	-1	1	6	1	2	1	1	1	0	0
1	2	3	4	-2	4	1	6	6	4	5	5

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
7.1

NTF 9 X 12 DOORS  
STIFFENER BAR E

0 SCALE 8

Figure 44

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 0

10/1/1

0	0	0	-1	0	-1	-1	-2	-2	-2	-1	-1
0	0	0	-1	0	-1	-1	-1	-1	-1	-1	-1
0	0	0	-1	-1	-1	-1	0	0	0	-1	-1
0	0	-1	0	-4	-1	-2	0	2	0	0	0
-2	0	-4	0	-11	2	-4	0	3	-1	0	1

SPEC  
7.1

NTF 9 X 12 DOORS  
STIFFENER BAR E

0 SCALE 8

Figure 45

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 1

10/1/1

0	0	0	-1	0	1	0	-1	-2	-5	-6	-6
1	1	0	-1	-1	0	0	0	-1	-3	-4	-4
2	2	1	-1	-2	0	1	1	1	0	-1	-2
3	3	2	2	-6	1	1	3	4	4	3	2
-2	0	-4	0	-11	2	-4	0	3	-1	0	1

SPEC  
7.1

NTF 9 X 12 DOORS  
STIFFENER BAR E

0  8  
SCALE

Figure 46

DISPLAY= PS2 /1000 . NODE= 1. SURFACE= 2

10/1/1

-1	-1	-1	0	-4	-3	-3	-2	-1	1	1	2
-1	-1	-1	-1	0	-2	-2	-2	-1	0	0	0
-2	-2	-2	-1	-1	-2	-3	-2	-1	-2	-2	-2
-4	-3	-5	-3	-3	-3	-5	-4	-1	-4	-4	-3
-2	0	-4	1	-11	2	-4	0	3	-1	0	1

SPEC  
7.1

NTF 9 X 12 DOORS  
STIFFENER BAR E

0 SCALE

Figure 47

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1

3	2	2	1
3	3	2	1
3	2	1	0
2	1	1	1
2	1	0	0
2	1	0	0
1	0	0	0
0	0	1	1
1	0	0	0
1	1	0	0
1	0	0	0
-1	0	1	2
1	0	0	0
1	1	0	0
1	0	0	0
-1	0	1	2

REPRODUCIBILITY OF THE  
PAGE IS POOR

SPEC  
8.1

NTF 9 X 12 DOORS  
STIFFENER BAR F

0 SCALE 11

Figure 48



DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1

3	2	1	0
4	3	2	1
3	2	2	1
1	1	1	1
2	-1	0	-1
2	1	0	0
2	1	0	0
-1	-1	0	1
1	0	0	-1
2	1	0	0
2	1	0	0
-1	-1	0	1
1	0	0	-1
2	1	0	0
2	0	0	0
0	-1	1	2

SPEC  
8.1

NTF 9 X 12 DOORS  
STIFFENER BAR F

0 SCALE 1

Figure 49

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1

3	2	2	2
3	2	2	1
2	1	0	0
3	2	1	0
2	1	1	1
1	1	0	0
0	0	0	0
2	1	1	1
0	0	1	0
0	0	0	0
0	0	0	0
1	6	1	2
0	0	1	0
0	1	0	0
0	0	1	0
0	0	1	3

SPEC  
8.1

NTF 9 X 12 DOORS  
STIFFENER BAR F

0 SCALE 11

Figure 50

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

10/1/1

-3	-3	-2	-1
-1	-3	-3	-2
-1	-2	-3	-4
-2	-2	-3	-5
-1	-2	-3	-5
0	-2	-3	-5
0	-2	-4	-5
-1	-2	-4	-5
-1	-2	-4	-5
0	-2	-4	-5
-1	-3	-4	-5
-2	-2	-4	-5
-2	-2	-4	-5
-1	-3	-4	-5
-1	-3	-4	-5
-2	-3	-4	-5

SPEC  
8.1

NTF 9 X 12 DOORS  
STIFFENER BAR F

0 SCALE 1

Figure 51

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 1

10/1/1

-3	-3	-3	-3
-1	-3	-3	-3
-1	-2	-2	-2
-2	-2	-2	-1
0	-2	-4	-6
0	-1	-3	-5
1	-1	-3	-5
-2	-2	-3	-4
0	-2	-4	-6
0	-2	-4	-6
0	-2	-4	-6
-3	-3	-4	-6
-1	-2	-4	-6
-1	-3	-4	-6
0	-3	-4	-6
-4	-4	-6	-8

SPEC  
8.1

NTF 9 X 12 DOORS  
STIFFENER BAR F

0 SCALE 11

Figure 52

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

10/1/1

-3	-3	-1	0
-2	-3	-3	-2
-2	-3	-4	-5
-1	-2	-5	-8
-1	-1	-3	-4
0	-2	-4	-6
-1	-2	-4	-7
-1	-1	-4	-8
-1	-2	-4	-5
-1	-3	-4	-6
-1	-3	-5	-6
-2	-1	-4	-7
-2	-3	-4	-6
-2	-3	-4	-5
-2	-3	-4	-6
-2	-2	-4	-5

SPEC  
8.1

NTF 9 X 12 DOORS  
STIFFENER BAR F

0 SCALE 11

Figure 53

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

3	1	1	0	0
0	1	1	0	0
1	1	0	0	0
2	1	0	0	1
4	2	2	2	2
5	0	2	2	2
3	0	1	2	3
3	1	1	2	3
5	2	2	3	4
6	-1	2	3	5
4	1	2	3	5
3	1	2	3	5
5	2	2	3	5
6	-1	2	4	6
4	1	2	4	6
3	2	2	4	5

SPEC  
9.1

NIF 9 X 12 DOORS  
STIFFENER BAR G

0 SCALE 11

Figure 54

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 . SURFACE= 1

3	3	1	0	0
0	2	2	1	0
2	2	1	2	2
1	-1	-1	1	4
4	4	2	2	1
-5	3	3	3	5
3	2	2	3	4
0	0	0	1	5
5	4	2	3	4
-7	2	4	4	5
4	3	2	4	6
0	0	1	2	5
5	4	2	3	5
-7	2	3	4	6
4	3	3	4	5
0	1	1	2	5

SPEC  
9.1

NTF 9 X 12 DOORS  
STIFFENER BAR G

0 SCALE 11

Figure 55

10/1/1

DISPLAY= PS1 /1000 . NODE= 1. SURFACE= 2

3	1	0	1	1
1	0	0	0	0
1	-1	0	0	0
4	3	1	1	0
4	1	2	3	2
5	-2	1	2	2
3	-1	0	1	2
5	3	2	2	2
5	0	2	3	4
8	-3	1	3	4
4	-1	1	2	4
6	3	3	4	5
5	0	1	3	5
8	-4	1	3	5
4	0	1	3	5
6	4	4	5	6

REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
9.1

NTF 9 X 12 DOORS  
STIFFENER BAR G

0 SCALE 11

Figure 56



DISPLAY= PS2 /1000 , NODE= 1. SURFACE= 0

10/1/1

1	-1	-1	-1	-1
-4	-2	-1	-1	0
-1	0	0	0	0
-1	0	0	0	0
3	-3	-4	-2	-1
-15	-8	-4	-2	-1
-7	-2	-1	-1	0
-2	-1	-1	0	0
3	-4	-4	-2	-1
-20	-11	-5	-2	0
-10	-4	-2	-1	0
-2	-2	-2	0	1
3	-3	-4	-2	-1
-20	-10	-4	-2	0
-10	-4	-2	-1	0
-2	-3	-2	0	1

SPEC  
9.1

NTF 9 X 12 DOORS.  
STIFFENER BAR G

0 SCALE 11

Figure 57

10/1/1

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 1

1	0	-1	-2	-2
-4	0	0	0	0
0	1	0	0	0
-1	-2	-1	-1	0
3	-2	-4	-3	-2
-15	-6	-3	-2	-1
-6	-1	0	-1	0
-2	-4	-3	-1	0
4	-2	-4	-3	-2
-20	-7	-4	-2	-1
-10	-2	-1	-1	0
-2	-6	-4	-1	0
4	-1	-3	-2	-1
-20	-6	-3	-2	-1
-3	-2	-1	-1	-1
-2	-6	-4	-1	0

SPEC  
9.1

NTF 9 X 12 DOORS  
STIFFENER BAR G

0 SCALE 11

Figure 58

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 . SURFACE= 2

1	-3	-2	-1	0
-4	-5	-2	-1	-1
-1	-1	-1	-1	-1
-1	1	1	-1	-2
2	-5	-4	-2	0
-15	-12	-5	-2	0
-8	-3	-2	-1	-1
-2	1	1	1	1
2	-5	-4	-2	0
-21	-15	-5	-2	0
-11	-5	-2	-1	0
-3	0	0	1	1
2	-5	-4	-1	0
-20	-15	-5	-1	0
-11	-5	-2	-1	0
-3	-1	-1	1	2

SPEC  
9.1

NTF 9 X 12 DOORS  
STIFFENER BAR G

0 SCALE 11

Figure 59

DISPLAY= PS1 /1000 . NODE= 1 . SURFACE= 0

10/1/1

3
0
1
2
4
5
3
3
6
8
4
3
6
8
4
3

SPEC  
10.1

NTF 9 X 12 DOORS  
SEAL FLANGE - TOP

0 SCALE 11

Figure 60

DISPLAY= PS1 /1000 . NODE= 1. SURFACE= 1

10/1/1

3
0
2
1
4
5
3
0
6
7
4
0
6
7
4
0

SPEC  
10.1

NTF 9 X 12 DOORS  
SEAL FLANGE - TOP

0 SCALE 11

Figure 61

10/1/1

DISPLAY= PS1 /1000 . NODE= 1 . SURFACE= 2

3
1
1
4
4
5
3
5
5
8
4
6
5
8
4
8

SPEC  
10.1

NTF 9 X 12 DOORS  
SEAL FLANGE - TOP

0 SCALE 11

Figure 62

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

10/1/1



SPEC  
10.1

NTF 9 X 12 DOORS  
SEAL FLANGE - TOP

0 SCALE 11

Figure 63

10/1/1

DISPLAY= PS2 /1000 . NODE= 1 , SURFACE= 1



SPEC  
10.1

NTF 9 X 12 DOORS  
SEAL FLANGE - TOP

0 11  
SCALE

Figure 64

2-3



DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 2

10/1/1



SPEC  
10.1

NTF 9 X 12 DOORS  
SEAL FLANGE - TOP

0 SCALE 11

Figure 65

DISPLAY= PS1 /1000 . NODE= 1 . SURFACE= 0 10/1/1

1	2	3	4	2	4	1	5	5	3	4	3
---	---	---	---	---	---	---	---	---	---	---	---

SPEC  
11.1

NTF 9 X 12 DOORS  
SEAL FLANGE - SIDE

0 8  
SCALE

Figure 66

DISPLAY= PS1 /1000 , NODE= 1. SURFACE= 1

10/1/1

1	2	2	4	5	4	1	5	5	2	3	2
---	---	---	---	---	---	---	---	---	---	---	---

SPEC  
11.1

NTF 9 X 12 DOORS  
SEAL FLANGE - SIDE

0 8  
SCALE

Figure 67

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1

1	2	3	4	-2	4	1	6	6	4	5	5
---	---	---	---	----	---	---	---	---	---	---	---

SPEC  
11.1

NTF 9 X 12 DOORS  
SEAL FLANGE - SIDE

0 SCALE 8

Figure 68

DISPLAY= PS2 /1000 , NODE= 1. SURFACE= 0

10/1/1

-2	0	-4	0	-11	2	-4	0	3	-1	0	1
----	---	----	---	-----	---	----	---	---	----	---	---

SPEC  
11.1

NTF 9 X 12 DOORS  
SEAL FLANGE - SIDE

0 SCALE 8

Figure 69

DISPLAY= PS2 /1000 , NODE= 1. SURFACE= 1

10 / 1 / 1

-2	0	-4	0	-11	2	-4	0	3	-1	0	1
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REPRODUCIBILITY OF THE  
ORIGINAL PAGE IS POOR

SPEC  
11.1

NTF 9 X 12 DOORS  
SEAL FLANGE - SIDE

0  8  
SCALE

Figure 70

DISPLAY= PS2 /1000 . NODE= 1 . SURFACE= 2 .

10/1/1

-2	0	-4	1	-11	2	-4	0	3	-1	0	1
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SPEC  
11.1

NTF 9 X 12 DOORS  
SEAL FLANGE - SIDE

0  8  
SCALE

Figure 71